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No. 8

THE IRON ORES OF CANADA

VOLUME I

BRITISH COLUMBIA AND YUKON

BY

G. A. YOUNG AND W. L. UGLOW

GEOLOGICAL SURVEY
DEPARTMENT OF MINES
OTTAWA
1926

CANADA

DEPARTMENT OF MINES

HON. R. B. BENNETT, ACTING MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

GEOLOGICAL SURVEY

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Iron Ores of British Columbia and Yukon

CHAPTER I[1]

GENERAL STATEMENT

British Columbia possesses deposits of iron ore, and has important coal fields. Direct trade routes lead from its coast to the other countries bordering the Pacific. These conditions and the existing local demand for iron have encouraged the hope that a profitable iron-making industry may be created within the province. An iron-making industry can be successful only if there exist an adequate source of raw material and markets for the finished product. As one step towards reaching a decision regarding the feasibility of establishing an iron-making industry, the Geological Survey at the request of, and in co-operation with, the Government of British Columbia, undertook an investigation of the known iron ore deposits of the province to determine, as far as practicable, the extent and character of the available iron ore resources. The results of this investigation are presented on the following pages, together with an account of such iron ore deposits as have been heretofore noted in the Yukon.

The field investigations were commenced in 1922 by G. A. Young with M. E. Hurst as field assistant, continued in 1923 by the same officer with T. D. Guernsey, R. E. Hayes, F. F. Osborne, and C. O. Swanson as field assistants, and concluded in 1924 by W. L. Uglow, who examined the various deposits along the west coast of Vancouver island and whose report thereon constitutes Chapter IV of this volume.

Adequate accounts of certain iron ore deposits were already available and such occurrences were not reinvestigated. Certain other deposits already reported upon were not re-examined because of their remoteness and the resulting prohibitive cost of transporting ore to any conceivable market. A very few other deposits which had not been adequately described were not revisited because of various reasons, but it is confidently believed that if these deposits had been examined, the resulting information would not have materially affected the conclusion that may legitimately be drawn from the facts presented in this report. No attempt was made to find and examine iron ore deposits merely rumored to exist in almost every district, but, on the other hand, considerable attention was paid in the field, and is given in this report, to certain occurrences of no possible value as sources of iron ore, but which have been cited as being commercially important.

No considerable market for iron ore as such has ever existed in the province. At one time there was a limited demand for iron ore as a flux, and also for a short period comparatively small quantities of ore were shipped

[1] By G. A. Young.

to a blast furnace in the state of Washington. As a result of such conditions prospecting for iron ore has not been as active as might be and the known deposits, for the most part, have been left untested, undeveloped, and almost in the same state as when first found. Conditions such as these preclude making precise statements regarding the probable or possible iron ore content of most of the larger deposits. Except in the case of certain occurrences of limonite, scarcely a single deposit is known to have been sampled in such a way as would indicate what would be the run-of-mine iron, and sulphur content of the ore. Though the object of the present investigation was to determine the amount and character of the iron ore of the various known deposits, it was not within the province of the Geological Survey to perform prospecting work on any deposit, even though in various instances a comparatively slight amount of work would have yielded valuable results. Nor was any attempt made to sample individual deposits, mainly because sufficient time was not available and because the almost wholly undeveloped state and variable composition of most of the deposits did not warrant any attempt to sample them thoroughly. Sufficient analyses are available to justify stating that, with the exception of a few occurrences specifically indicated on later pages, all the known iron ores of British Columbia so far as regards phosphorus are of Bessemer quality and none is known to contain any appreciable quantity of titanium. All the magnetite ore deposits contain pyrite, but in some deposits the sulphur content must be very low. In certain occurrences the copper content is appreciable.

Though, for reasons already given, it is not possible to give precise statements of the ore content of the various deposits, yet it is believed that the results obtained do indicate with reasonable precision the order of magnitude of the total content of the known iron ore deposits. Many of the deposits are each certainly incapable of profitably affording more than a few thousand tons of merchantable ore. Other deposits present features which indicate that their individual ore content scarcely can exceed a certain, though in some instances large, amount. The remaining deposits include those concerning which the available information is such that no positive statements are warranted, but the number of such deposits is not large and in most cases it is practicable to indicate limiting values to their contents with some degree of assurance. In the following table an attempt has been made to indicate the amount of iron ore available in deposits thought to contain more than 25,000 tons of ore. It is believed that the total amount would be markedly increased through the discovery of other deposits if an open market were ever created for iron ores such as are now known to occur in British Columbia. The estimated amount of iron ore available at present would, perhaps, be somewhat larger if it had been possible to examine some three or four known deposits concerning which adequate information is lacking, but though some or all of these unvisited deposits may be comparatively important, yet it is unlikely that any one is of first rank in importance, since so little authentic information regarding any of them is available.

In the following table a content of 50 per cent or more of metallic iron in the case of magnetite and hematite deposits, is considered to constitute ore.

Estimated Minable Iron Ore Content of Deposits in British Columbia Believed to Hold 25,000 Tons or More of Iron Ore[1]

1	2	3	4	5	6
Locality No.[2]	Locality of deposit	Kind of ore	Tonnage almost certainly present	Tonnage probably present (includes tonnage in column 4)	Tonnage possibly present (includes tonnage in columns 4 and 5)
1	Summit ck., Zymoetz r.	Limonite	500,000	1,000,000	1,000,000 +
7	Iron Duke, Louise is.	Magnetite			100,000 to 150,000
8a	Apex mt., Moresby is.	Magnetite		200,000±	300,000
10f	Magnet claim, Moresby is.	Magnetite			175,000 (?)
10g	Jessie and Harriet claims, Moresby is.	Magnetite			25,000 to perhaps 200,000
10h	Plunger claim, Moresby is.	Magnetite			10,000 to 50,000
10m	Chrysanthemum claim, Moresby is.	Magnetite			75,000
16	Chromium creek	Hematite			100,000 +
17	Iron Crown, Klaanch r.	Magnetite			100,000 or perhaps much more
20a	Iron r., V. I.	Magnetite			400,000
20b	Iron Hill, V. I.	Magnetite			1,700,000
24	Prescott mine	Magnetite	100,000	350,000	
	Paxton mine	Magnetite		300,000	1,500,000 and upwards
	Lake mine, Texada is.	Magnetite		90,000	
29	Taseko r.	Limonite	670,000		
31a	Glen mine, Kamloops	Magnetite (much apatite)			175,000 to 325,000
31b	Magnet claim, Kamloops	Magnetite (much apatite)			250,000 +
32b	Nicola, south of	Limonite			25,000 to several hundred thousand
46a	Conqueror claim, V.I.	Magnetite		24,000	(?)
46d	Sirdar claim, V.I.	Magnetite		19,825	96,000
46e	Little Bobs-Baden Powell, V.I.	Magnetite	37,300	99,000	250,000 +
47a	Sarita r., V.I.	Magnetite		30,000	(?)
54a	Glengarry-Stormont claims, V.I.	Magnetite		60,000	170,000 +
57b	Prince's Iron claims, V.I.	Limonite			Much less than 2,000,000

With the exception of a magnetite deposit near Beasley (locality 37), Nelson mining division, concerning which no information is available, the deposits not mentioned in the above table are considered either to be valueless, or to hold less than 25,000 tons of merchantable ore, or to be of doubtful value. Even in the case of those deposits considered to be of doubtful value, few, if any, are thought to contain as much as 25,000 tons of ore; in most cases the value of such deposits remains in doubt either because the iron ore occurs in such irregular bodies as to forbid estimating their possible extent, or because though the deposits as now displayed at the surface do not appear to be of much promise, yet the distribution and character of the outcrops are such that a possibility remains that the deposits are of some real value.

[1] Authorities for estimates, other than the present writer: 1 and 29, J. D. MacKenzie; 46a, 46d, 46e, 47a, 54a, and 57b, W. L. Uglow in this report; 16, V. Dolmage.

[2] These numbers are attached to the descriptions of the individual deposits in Chapters III and IV.

Exclusive of the several deposits of limonite, the hematite of Chromium creek (locality 16), and the apatite-rich, magnetite bodies near Kamloops (localities 31a and 31b), the other properties, seventeen in number, occur on Queen Charlotte islands and Vancouver island. The total amount of ore considered to be almost certainly present, exclusive of the untabulated, comparatively trifling amounts of a number of the deposits, is only 137,300 tons. The total amount of ore probably present is, in round numbers, 1,200,000 tons (this sum includes the aforementioned 137,000 tons). The stated amount of ore of this category may be quite erroneous in the case of any one deposit, but probably the total amount is not far from being correct. The total possible ore content, in round numbers, is estimated to be 5,000,000 tons (this sum includes the aforementioned 1,200,000 tons). In this case the amounts assigned to the individual deposits are in most cases based on a very slender body of facts, and, therefore, the tonnage estimates are really not much more than an expression of what is considered to be the relative values of the various deposits. As already stated in general terms and as afterwards repeatedly indicated in the descriptions of the individual properties, the deposits are so poorly exposed at the surface, have been so slightly, if at all, developed, and are so irregular in form and composition, that in practically no single instance is it proper to state the amounts of actual, probable, and possible ore, using these terms with the meanings now commonly attached to them by mining engineers. A fairly accurate estimate of the probable value of most of the more important magnetite deposits could be obtained, in any single instance, by a comparatively small amount of work and it is the present writer's belief that if such work were performed the total probable content of all the major deposits would prove to be not less than 2,000,000 tons and might greatly exceed that figure.

As regards the limonite deposits, the values given for those of Summit creek (locality 1) may be low, but those of Taseko River area (locality 29) must be nearly correct. Unfortunately both these groups of deposits are at a very considerable distance from railways and steamship routes. The deposit near Nicola lake (locality 32b) is comparatively close to a railway, but is otherwise isolated. The limonite deposits of Quatsino sound (locality 57b) may be extensive, but the amount of limonite of reasonably high grade may be very low.

It seems certain that the magnetite deposits of the coast districts should be considered as being the primary sources of native iron ore that might support an iron-making industry in British Columbia.

CHAPTER II[1]

ORIGIN, FORM, AND DISTRIBUTION OF IRON ORES

Iron ore deposits form in many ways and assume various shapes, but most deposits originate either as sediments or precipitates or else as direct products of igneous action. A third important group of iron ore deposits includes those which have been produced by the prolonged decay, under special conditions, of great volumes of rock whose iron content is preserved, whereas other constituents are largely carried away. The sediments and precipitates tend to occur in beds, though in some cases only greatly modified parts of the beds constitute the iron ore deposits. The sediments and precipitates generally are associated with bedded strata and may be of any geological age. The limonites or bog iron ores are a special class of the precipitates and are deposited at the surface of the earth by waters which leach iron from rocks that may be of igneous or sedimentary origin. A special feature of the sediments and precipitates, that is, the bedded ores, is that when they do occur within a geological formation they tend to be a constant feature of the formation, although only locally may they be rich enough in iron to constitute an ore.

The iron ores that have formed as direct products of igneous action occur, as hardly need be said, in regions where igneous products are manifest, but not all regions so characterized are the sites of iron ore deposits. The iron ores of this group in some cases occur in masses within or adjacent to the parent rock of which they are only a special phase. In other cases they form vein-like bodies or they occur as impregnations or replacements somewhat younger than the associated igneous rock and situated within it or some other neighbouring body of rock. Many of the impregnations and replacements are irregular of form, but some preserve the bedded structure of their host and thus simulate bedded deposits.

From the foregoing general remarks it is apparent that iron ores of special types are likely to characterize considerable regions and that it is to be expected that other extensive regions may be barren of such ores. There is a very special connexion between the presence or absence of iron ore and the general geological history of any given region. This general condition is exemplified in the case of British Columbia and Yukon territory. The Rocky mountains, which define the greater part of the east border of British Columbia, are formed of folded and faulted strata ranging in age from Precambrian to Tertiary. Igneous rocks are rare and occur mainly in only two limited areas. There is, therefore, reason to suppose that iron ores of igneous origin will only rarely, if ever, be found in the Rocky mountains. In the extreme southwest, adjacent to Columbia River valley, on Bull river and Sand creek (locality 42, Figure 2), limited deposits of hematite have been found. On Bull river, the hematite is associated with a dark, basic dyke; on Sand creek, it occurs in what seems like a thin bed with which are associated masses of vein quartz. These two deposits possibly are igneous products. They are the only iron ore occurrences as

[1]By G. A. Young,

yet known in the Rockies in British Columbia. Bedded, ferruginous strata appear to be absent from the Precambrian and later strata, unless the Sand Creek occurrence is of sedimentary origin.

Along the western flanks of the Rocky mountains, Precambrian sediments are intermittently displayed, but west of the Rocky Mountain trench strata of this age are broadly developed and in the south extend west beyond Kootenay lake. These measures over wide districts appear to be lacking in any strata even remotely resembling bedded iron ores, but south of Nelson, close to the International Boundary, near Salmon river (locality 38), a thin bed of magnetite occurs in the sedimentary strata and may be a ferruginous sediment. Also near Crawford bay (locality 39) on the east side of Kootenay lake, hematite occurs associated with sedimentary rocks. These two occurrences represent the only known possible examples of sedimentary iron ores throughout the interior of British Columbia.

In northeastern British Columbia, where the province extends eastward into the region of Cretaceous sediments bordering the Rocky mountains on their eastern side, certain horizons in the Cretaceous beds are characterized by concretionary masses of clay ironstone. It is not inconceivable that in places beds of considerable lateral extent may be rich enough in iron to warrant being designated low-grade iron deposits, but no such deposits have yet been found there nor in the eastward and southward extension of the Cretaceous rocks in Alberta where, in places, similar nodular, ferruginous bodies are abundant. In the Cretaceous beds of eastern Vancouver island, on Sable river (locality 23), a thin bed of clay ironstone has been found and this is the only known example of sedimentary iron ore occurring with any of the stratified rocks of the regions along the Pacific coast of the province.

All available evidence seems to indicate that British Columbia lacks any extensive, bedded, iron formations or any valuable sedimentary iron ore deposits except, possibly, the limonite or bog iron ore deposits. The limonite ores occur in deposits of considerable extent in various localities, as on Zymoetz river (locality 1), Taseko river (locality 29), and at Alta lake (locality 25) in the western part of the province, and near Nicola lake (locality 32) in the southern interior. What appear to be less important deposits occur elsewhere also. All the limonite deposits that have been closely investigated have been found to have been produced by springs which derive their iron content from pyritiferous strata, or, as in the Peace River country (locality 44), from nodular clay ironstone in Cretaceous strata. These deposits, so far as known, are all of Recent age, for they naturally occur in relatively low situations and any that existed in Tertiary time rarely, if ever, escaped destruction during the Glacial period. The requisite conditions for the production of limonite bodies doubtless exist in many parts of central and western British Columbia and the total amount of limonite may be great, but large, single deposits are exceptional and not the rule. Their mode of formation is such that individual deposits or groups of deposits may have a very considerable areal extent, but the deposits are always comparatively shallow and the content of the individual bodies usually is disappointingly low.

In Yukon territory, in Mackenzie mountains, and in Ogilvie mountains which extend westward from them towards the Alaska boundary north of Yukon river, there are indications of the existence of one or more sedimentary iron-bearing formations. Fragments of banded,

siliceous, hematite ores are plentiful in the Ogilvie range in the watershed between Stewart and Peel rivers (localities 2 and 3, Figure 1) and it is claimed that extensive bodies of hematite have been seen.

Residual iron ores of any value are not known in British Columbia or Yukon territory. Deposits of this type, produced by long-continued weathering and the concentration of the iron contents of large volumes of rock, are not common the world over and would hardly be expected to occur, or if they once did occur, to have been preserved in either British Columbia or Yukon territory.

Though in British Columbia sedimentary iron ores appear to be practically lacking, many iron ore deposits of igneous origin are known and doubtless many more await discovery. All the known deposits of this type, except those of Bull river and Sand creek, which as already mentioned may not be of igneous origin, lie west of the Rocky Mountain trench in regions where granitic invasions of Mesozoic age prevail. Such deposits more particularly characterize the Pacific Coast districts along the west edge of the Coast Range batholithic area, which extends from the Fraser delta northwest the whole length of British Columbia and on into Yukon territory. They also occur along or near the eastern edge of the same batholithic area in Yukon territory, and in several districts in southern British Columbia. Iron ores of igneous origin also characterize several districts in the southern interior of the province, but so far as known are rare throughout the interior country from Kamloops and Shuswap lakes, north into Yukon River basin.

Hematite deposits of igneous origin are not common and most of them are not of economic value. In southeastern British Columbia, near Kitchener (locality 40, Figure 2), bodies of hematite of apparently small cross-sections occur within a narrow, nearly straight zone which is at least 6 miles long and crosses broadly folded Precambrian sediments and basic sills. Vein quartz is associated with the hematite, which replaces the country rock and appears to have developed in shattered zones. Similar deposits are reported to occur southward of Kitchener. The origin of the hematite is not definitely known, but it is thought that it and the granitic rocks of batholithic areas not many miles away may be related. The granitic rocks are generally supposed to be Jurassic. Near Finger lake (locality 43), in central British Columbia, hematite occurs in stringers and small masses in narrow zones of sheared volcanic rocks which the iron oxide replaces. On Chromium creek (locality 16) near the eastern edge of the Coast Range batholithic area, hematite occurs in a bed of tuff which, in places, it completely replaces. Farther south, on Tipella mountain (locality 27), Harrison lake, hematite in small, irregular patches replaces granitic rocks of the eastern margin of the Coast Range batholithic area. These various occurrences are presumed to be of Mesozoic age and related to the granitic rocks of Jurassic or Cretaceous time, but near Merritt (locality 32), in the southern interior, narrow veins of hematite occur which may be of Tertiary age, for they traverse volcanic rocks doubtfully referred to this era.

Magnetite bodies of igneous origin are numerous and most of them replace the rocks with which they occur, but in a few places the deposits possess all the essential characters of veins. Magnetite bodies of this nature occur near the south shore of Kamloops lake (locality 31) where in several localities groups of parallel, curving veins of magnetite traverse

a plutonic mass varying in composition from gabbro to monzonite. These veins are characterized by the presence of a variable, in some cases large, amount of apatite. The plutonic rock is probably of Mesozoic age. Vague reports are current of the existence of other magnetite deposits to the southward within the limits of the basic plutonic mass and it may be that the magnetite veins are related to their host, the gabbro-monzonite body.

In Tulameen district (locality 33) is the only recorded example in British Columbia of magnetite bodies occurring as an integral part of their plutonic host. In this district, a body of Jurassic pyroxenite carries much magnetite as a normal rock constituent, but in places the quantity of iron oxide greatly increases and the magnetite forms short, irregular veins, or small, irregular masses.

The more common, contact-metamorphic, replacement type of magnetite deposits is known in the southern interior of British Columbia from near Nelson west to the Boundary district (localities 34, 35, 36, and 37). The bodies in the Boundary district and in Franklin camp, have been mined for their copper and gold content, but some of them have been described as being in part nearly solid magnetite. Very little is known of the magnetite occurrences farther east in the vicinity of Nelson, but they also appear to belong to the contact-metamorphic class, and to have developed in the vicinity of the edges of large bodies of Mesozoic, presumably, Jurassic granite or granodiorite. Mineralized bodies rich in magnetite and in some cases distinctly of the contact-metamorphic type occur north of Lillooet lake (locality 28) along the eastern border of the Coast Range batholith, but all of these deposits so far discovered have been regarded as possibly sources of copper and gold and not of iron.

The magnetite deposits are most numerous along the mainland Pacific coast and the bordering islands. They occur in various forms and with different associations. Examples may be chosen to illustrate a gradation from nearly pure bodies of magnetite to others too low in magnetite to be considered an iron ore, but sufficiently high in chalcopyrite to be classed as a copper ore. Pyrite is a common constituent of the magnetite bodies, but the amount present in some cases is inconsiderable. In some instances the sulphide is fairly evenly distributed through the whole body of ore, in other cases it tends to be concentrated towards the edges of the deposit. Silicates such as garnet, epidote, pyroxene, and hornblende are invariably present, but in amounts that vary widely from deposit to deposit or from one spot to another within a single deposit. In some occurrences, large and small masses of partly altered rock are common, in other examples they are rare. As a general rule, the boundaries of the deposits are sharply defined against country rock and within any single deposit the passage from low-grade into high-grade ore is usually very rapid. The individual deposits vary in size from masses a few feet in diameter to bodies hundreds of feet long. The shapes and attitudes of the bodies are varied, for the deposits replace the rocks with which they are associated and the outlines assumed seem governed by the structures presented by the country rocks. The relations existing between the form and attitude of the deposits and the structures presented by the neighbouring strata are in some cases very plainly evident, but in many instances they may only be surmised because of the undeveloped condition of the mineral bodies and the characteristic dearth of natural exposures at critical points.

The general region within which the deposits occur is mainly underlain by one or more thick assemblages of sedimentary and volcanic strata, which have been penetrated by numerous bodies of plutonics and are bounded on the east by the long, broad area of granitic rocks forming the Coast range. The plutonic rocks of the eastern batholithic area and of the smaller areas on Vancouver, Queen Charlotte, and other islands of the Pacific coast, are mainly, if not solely, of Jurassic age, but may belong to successive invasions, for in places one rock variety may be seen to cut another. The plutonics in composition range from granite to gabbro, but are mainly granites, granodiorites, and diorites. The strata cut by the granitic rocks appear to be very largely of Triassic age. They consist of flows, sills, and other intrusive bodies of dark basic rocks and of thick and thin assemblages of bedded tuffs, argillaceous, arenaceous, and calcareous strata. The limestones in places are hundreds of feet thick and not infrequently occur isolated amongst the dark effusives and intrusives. Over large districts the volcanics and sediments, though they may be closely folded, are not highly metamorphosed. Within the boundaries of the Coast Range batholithic area, similar strata, in part highly metamorphosed, lie in the granitic rocks in the form of detached masses which range in size from mere blocks to such as are many miles long and proportionately broad.

Some of the magnetite deposits occur along contacts between the granitic rocks and the volcanic and sedimentary assemblages; none is known to be far removed from such contacts, and perhaps never lies so far away as a mile from the boundary of a large granitic body. Many of the mineral bodies lie wholly or mainly in limestone and even though many others of the deposits either indisputably or apparently occur in other types of rock, there is usually limestone exposed in their immediate neighbourhood. This general relationship has induced some observers to conclude that virtually all the magnetite deposits essentially replace limestone, but some of the bodies, as on Texada island (locality 24), indisputably replace finely textured intrusives or effusives and even the granitic rocks. The common presence of limestone does seem to imply, however, that limestone in some way promoted the formation of the magnetite deposits.[1]

Away from the magnetite bodies the contacts between invading granitic rocks and the sediments and volcanics are usually sharp and there is little or no evidence of contact metamorphism. The alterations exhibited in the immediate vicinity of the mineral deposits are due to agents which followed the granitic intrusions, for the plutonic rocks where they adjoin mineral deposits are also metamorphosed, and are replaced by silicates and magnetite. The fluids or vapours which produced the magnetite-bearing masses apparently came from the same source as the intrusions and were guided to and along the edges of the intrusive masses without leaving any as yet recognizable trace of their migration, until within circumscribed areas they abruptly attacked the country rock and wholly or partly transformed it into bodies of magnetite and silicates. Much of the material of these replacement bodies was contributed by the fluids or vapours. The replaced matter was carried away without leaving any as yet identified traces of the route followed. The mineral masses nowhere present features incompatible with the assumption that they are replacement deposits. A few have vein-like or dyke-like outlines, but even these are probably only special phases of the same general process of replacement.

[1] Swanson, C. O.: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, p. 143.

A special feature of almost all the deposits is the sharpness of their outlines. Within spaces of a few inches or a few feet, unaltered or only slightly altered country rock gives way to highly altered material or to almost solid masses of magnetite and secondary silicates. Where limestone (usually crystalline) is the host the contact between pure limestone and the solid bodies of magnetite, garnet, etc., in many cases is a sharp line. Away from this boundary the limestone for an indefinite distance is wholly unaltered, except in so far as it has been rendered crystalline. Within the areas of alteration, masses of only partly destroyed country rock are not infrequent. Apparently the action of the mineralizing agents was confined, in any one place, to comparatively narrow limits and although it seems to be a general rule that the deposits do not occur singly but occur in many places over districts miles in length, yet, as numerous examples indicate, the limits of the individual masses seem to bear a direct relation to various locally developed, major geological structures. An important conclusion deducible from various facts detailed in the two succeeding chapters is, that no individual deposit extends to great depths and that an extensive outcrop does not always imply a considerable vertical thickness. It is also concluded that in any given district the discovery of a single body of magnetite is an almost certain indication that other bodies exist or did exist nearby either vertically or horizontally or in both directions, but there are no known grounds for supposing that the undiscovered bodies lie immediately adjacent to the known deposit. A third main conclusion is that if in any given case the attitude of a mineral body is not clearly apparent it is not safe to assume that the mass extends in any direction more than a few feet beyond its observed limits, whether these be against drift or solid rock. A further widely applicable generalization is that the mineralogical composition and, therefore, the iron content, of the individual deposits, is variable. Considerable parts of every deposit consist of low-grade materials and the distribution of the high-grade material appears to follow no predictable course.

The foregoing remarks apply to the usual type of magnetite deposit encountered along the Pacific coast, but some of the bodies there found, as on Pitt (locality 3) and Porcher (locality 2) islands, and the west side of Seymour inlet (locality 14) differ from the ordinary type in that they are more of the nature of impregnations and have developed within comparatively narrow though in some cases long zones, in schistose sediments and volcanics. In places the impregnations consist of massive bodies of magnetite, in other places the iron oxide occurs in streaks and vague patches. These impregnations lie close to the edges of granitic bodies and appreciable amounts of secondary silicates, including garnet, are present. Such deposits are considered to be a special phase of the more typical contact-metamorphic deposits.

The definitely known magnetite deposits occur at intervals along the whole length of the Pacific coast of British Columbia and have been found in southern Yukon along or close to the eastern edge of the Coast Range batholithic area. In addition to the publicly known deposits, there is substantial evidence that many others have been found, and it seems almost certain that many more deposits, a majority of which are doubtless of no value, remain still undiscovered on the islands and mainland coast within areas of sedimentary and volcanic strata adjacent to the edges of granitic bodies.

CHAPTER III[1]

IRON ORE OCCURRENCES IN YUKON TERRITORY AND IN BRITISH COLUMBIA EXCLUSIVE OF WESTERN VANCOUVER ISLAND

YUKON

(1) Tatonduk River and Cathedral Creek

Source of Information. Cairnes, D. D.: "The Yukon-Alaska International Boundary between Porcupine and Yukon Rivers"; Geol. Surv., Canada, Mem. 67, pp. 44-45, 112 (1914).

GENERAL DESCRIPTION

A group of not greatly deformed nor highly metamorphosed sedimentary strata with associated volcanics, known as the Tindir group, occurs at intervals between Porcupine and Yukon rivers in the vicinity of the International Boundary. The Tindir group is considered to be older than Middle Cambrian and may be Precambrian. The strata are largely clastics, but include beds of limestone; they are several thousand feet thick.

Regarding certain, possibly local, developments of the Tindir strata, Cairnes[2] writes as follows. "Iron containing minerals, chiefly hematite, magnetite, and their oxidation products, comprise a considerable percentage of some of the beds of the Tindir group to the south of Cathedral creek. In places, limited portions of these deposits occurring in beds ranging from 2 to 10 feet in thickness, contain up to 30 per cent or even 40 per cent metallic iron. Also, on a small tributary of Tatonduk river flowing into it from the north, certain peculiar reddish conglomerates resembling consolidated boulder clay . . . . contain considerable hematite in places. Limited portions of this conglomerate appear to contain from 5 per cent to 25 per cent metallic iron. A few local seams also outcrop in the dark shales . . . . exposed along Tatonduk river in the vicinity of the boundary line, but none were noted having a thickness exceeding 2 inches."

These beds of low-grade iron ore are presumably of sedimentary origin and if so they may characterize particular horizons within the Tindir group and, possibly, in places may form comparatively thick beds of relatively high-grade iron ore. Strata resembling the Tindir beds have been recognized far to the east in Ogilvie mountains and it may be that the hematite and magnetite of Hart, Wind, and other rivers (*See* immediately succeeding descriptions) come from Tindir beds.

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[1] By G. A. Young.

[2] Op. cit., p. 112.

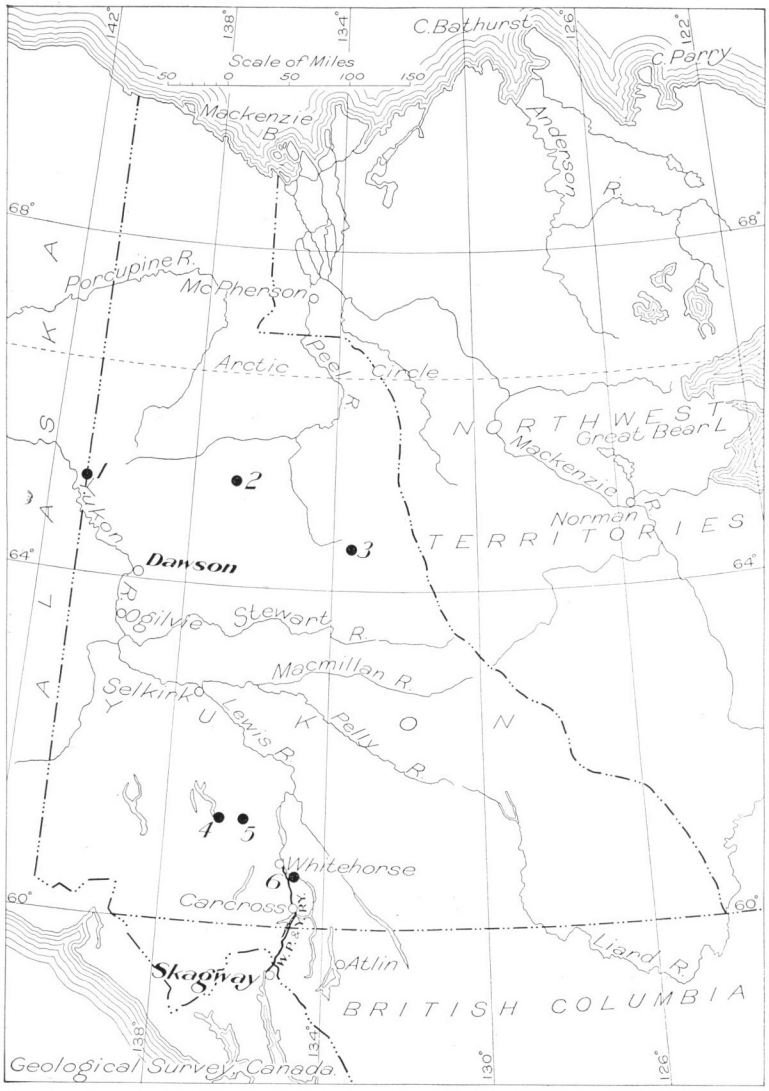


Figure 1. Index map of Yukon territory showing positions of iron ore occurrences. 1, Tatonduk river and Cathedral creek; 2, Hart river; 3, Wind, Bonnet Plume, and Rackla rivers; 4, Giltana lake; 5, Nordenskiöld river, Mack's Copper; 6, Whitehorse copper belt.

(2) Hart River

Mr. W. E. Cockfield has furnished the following note. "Frank Rae of Dawson has submitted a specimen of fairly pure hematite. This specimen is reported to come from the east fork of Hart river, about 30 miles north from the height of land between Yukon and Mackenzie River basins. Mr. Rae claims that there are extensive deposits of hematite in that vicinity."

This reported occurrence of iron ore presumably is of the same general nature as that of occurrences farther east in the basin of Wind and other rivers. *(See* immediately succeeding description.)

(3) Wind, Bonnet Plume, and Rackla Rivers

Source of Information. Keele, J.: "Report on the Upper Stewart River"; Geol. Surv., Canada, 1906, p. 22.
Camsell, C.: "Report on the Peel River and Tributaries, Yukon and Mackenzie"; Geol. Surv., Canada, 1906, pp. 23 and 46.

"The existence of large bodies of iron ore at the headwaters of the Wind and Bonnet Plume rivers has been known for some years. Outcrops of this ore were seen by a few of the gold-seekers who journeyed to the Yukon by this route. The drift from these bodies is widespread in the basin of both the Peel and Stewart rivers . . . . On Rackla river . . . . . which apparently heads near the source of the iron, larger fragments are found" . . . .[1]

"Quantities of float of a banded jaspery iron ore were found at the mouth of Bear river and I am informed . . . . that the float ore becomes more common higher up the stream and on the portage to the Bonnet Plume river forms a large proportion of the drift. . . . The same float also occurs in great quantities on the Bonnet Plume river and also on the Snake. . . . ."[2]

Keele states that the pebbles of ore . . . . "show an exceedingly fine-grained, very compact hematite some of which also contains thin bands of red jaspilite. Small boulders showing bands of pure ore 4 or 5 inches thick were found near the forks of Rackla river." The iron ore float is described by Camsell in much the same terms, except that magnetite is stated to accompany the hematite.

The distance between Hart river *(See* preceding description) and Rackla river is 140 miles in a southeasterly direction about parallel to the general trend of the strata of Ogilvie mountains. The same general type of iron ore appears to be present somewhere in the respective watersheds of the two rivers. The ore is presumably of a sedimentary type and possibly outcrops elsewhere in the general vicinity of the divide between Mackenzie and Yukon rivers. The associated strata may be the equivalents of the Tindir group, presumably of Precambrian age, which, as developed near the International Boundary, 120 miles west of Hart river, also carries bedded iron ores *(See* page 11).

[1] Keele, J.: Op. cit., p. 22.
[2] Camsell, C.: Op. cit., p. 23.

(4) Giltana Lake

Source of Information. Cairnes, D. D.: "Preliminary Memoir on the Lewes and Nordenskiöld Rivers Coal District, Yukon Territory"; Geol. Surv., Canada, Mem. 5, pp. 57-58 (1910).

GENERAL DESCRIPTION

The magnetite bodies near Giltana lake may be reached by a trail, 65 miles long, which leaves the Whitehorse-Dawson road 6 miles south of Montague and follows a westerly course for the most part upwards along Nordenskiöld River valley. Giltana lake lies a few miles east of the northeastern edge of the batholithic area of the Coast Range intrusives of Jurassic or, possibly, early Cretaceous age. The country east of the batholithic area is occupied by groups of sedimentary and volcanic strata ranging in age from Precambrian to Tertiary and the older divisions are highly deformed, in some instances greatly metamorphosed, and are penetrated by bodies of Mesozoic granite, granodiorite, etc.

"On the northeast side of . . . . (Giltana) lake, the claims are chiefly located over the face of a hill which rises to about 1,200 feet above the lake. The formation here is chiefly mica schist interbanded with . . . . beds of quartzite and limestone, the latter being, generally, only 3 to 4 feet thick, but, in places . . . . 50 feet. . . . The beds dip into the hill at low angles so that the . . . . schist bands extend along the face of the hill . . . . maintaining an almost horizontal outcrop. In places these bands are mineralized with magnetite generally carrying copper minerals. . . . The . . . . schists show all degrees of mineralization and replacement. . . . The best of these mineralized bands . . . . generally average from 6 to 10 feet in width . . . . one of 20 feet was seen. . . . These can be traced generally from 50 to 100 and even 200 feet when the . . . . minerals . . . . (gradually) disappear or, at times, follow other parallel bands. Three prominent and other less important bands were observed. . . . The ore deposits . . . . are apparently genetically connected with the intrusive granites in the vicinity". . . .[1]

For further remarks on this deposit, *See* conclusion of description of "Whitehorse copper belt," page 16.

(5) Nordenskiöld River, Mack's Copper

Source of Information. Cairnes, D. D.: "Preliminary Memoir on the Lewes and Nordenskiöld Rivers Coal District, Yukon Territory"; Geol. Surv., Canada, Mem. 5, pp. 55-56 (1910).

GENERAL DESCRIPTION

The magnetite body known as "Mack's Copper" may be reached by the trail which leads from the Whitehorse-Dawson road, westward up Nordenskiöld River valley. About 35 miles west along this trail a branch trail ascends the hills northwards and leads to the deposit which is . . . "practically on the summits at about 4 miles from and 1,900 feet above the valley" . . . . of Nordenskiöld river. The deposit lies about 20 miles northeast of the east border of the batholithic mass of the Coast Range intrusives and within an area occupied by variously deformed and metamorphosed sedimentary and volcanic groups which range in age from Precambrian to Mesozoic and are invaded by plutonic bodies of Jurassic or Cretaceous age.

[1] Cairnes, D. D.: Op. cit., pp. 57-58.

Practically all the ore to be seen . . . . "appears to be on one claim, and occurs in a fine-grained, greenish andesite at or near its contact with limestone. The ore consists chiefly of magnetite, with hematite in minor quantities, both more or less impregnated with copper minerals. . . . . The main mass of mineral is in the form of a small hill of almost solid iron ore, about 200 feet wide, and from 300 to 400 feet long. On the top of the hill generally there are no indications of copper (sulphide) . . . . but over the south side of the hill the iron ore carries considerable copper. . . . An open-cut on the adjoining hill to the west . . . . (discloses) ore . . . . only 10 to 12 feet wide." . . .[1]

For further remarks on this deposit, *See* conclusion of the following description of the "Whitehorse copper belt."

(6) Whitehorse Copper Belt

Source of Information. McConnell, R. G.: "The Whitehorse Copper Belt, Yukon Territory"; Geol. Surv., Canada, 1909, pp. 7-9, 20-36.

GENERAL DESCRIPTION

Bodies of magnetite with varying amounts of hematite and sulphides occur within a zone or belt 12 miles long in the valley of Lewes river in the vicinity of Whitehorse. These bodies have been extensively mined for their copper contents. The oldest rocks in the immediate vicinity are limestones of Palæozoic or early Mesozoic age. They have been broken through and largely destroyed by three successive igneous invasions, so that only fragments remain. The earliest igneous rocks are porphyrites of various kinds and form sills up to 1,000 feet thick. Later than them are bodies of granite, diorite, and gabbro, and intermediate varieties. These rocks occupy a large part of the district and may be outlying masses of the Coast Range intrusives. Last of all are very numerous dykes. The remnants of the limestone are bodies which range in size from such as are a few feet across to irregular masses several miles long and one or more miles wide. The beds stand at all attitudes.

The limestone in the vicinity of the granitic areas is metamorphosed for the most part to a coarsely crystalline rock, but at irregular intervals the affected zone widens and the limestone is charged in a variable degree with a great variety of minerals. The iron and copper deposits occur chiefly in these mineralized zones within the limestone masses, but essentially similar deposits occur also within the granitic rocks at considerable distances from any visible limestone. The mineralized bodies seldom occur in the porphyrites.

Magnetite and hematite are widely distributed and both occur in large masses. Magnetite is especially abundant and is seldom absent from the mineralized areas. Lenses of this mineral range in size from a few inches up to 360 feet in length and are found at intervals along the whole length of the mineralized belt, mostly in limestone. Hematite is less common, but was the principal mineral in one very large body. The largest magnetite body was 360 feet long. All the magnetite masses are sprinkled with grains and small masses of bornite and chalcopyrite. Other sulphides occur, as well as garnet, pyroxene, epidote, etc., the silicates being especially abundant about the borders of the mineralized areas.

[1] Cairnes, D. D.: Op. cit., p. 55.

The deposits at Whitehorse and those already described as occurring respectively near Nordenskiöld river and Giltana lake are essentially of the same general character. They are contact-metamorphic, replacement deposits which have developed mainly in strata near or at the edge of invading bodies of granitic rocks. The three localities occur within a distance of 75 miles and lie 7 to 20 miles northeast of the east edge of the batholithic area of the Coast Range intrusives with which, in all probability, are connected the outlying bodies of granitic rocks that gave rise to the ore deposits. Presumably other iron ore-bodies occur in the territory adjacent to the edge of the main body of Coast Range intrusives which extends northwest past Giltana lake for a distance of 50 to 75 miles or more. These deposits are counterparts of the magnetite bodies which occur west of the Coast Range batholith along the Pacific coast of British Columbia and like them are irregular in form and variable in composition, but locally contain many thousands of tons of magnetite iron ore with a comparatively low sulphur and insignificant copper content.

BRITISH COLUMBIA

OMINECA MINING DIVISION

(1) Summit Creek, Zymoetz River

Source of Information. MacKenzie, J. D.: Geol. Surv., Canada, Sum. Rept. 1915, pp. 67-69.

GENERAL DESCRIPTION

The following account of this limonite deposit is derived from the report by Mackenzie, which is accompanied by a geological plan of the ore occurrence. The property has also been described by W. M. Brewer.[1]

"The bog iron ore property owned by the North Pacific Iron Mines, Limited, of Prince Rupert, is situated on Limonite (Summit) creek, a tributary of the Zymoetz (Copper) river, 38 miles east of Copper city on the Skeena. It is 6 miles west of the summit of the Zymoetz River-Telkwa River trail, and about 40 miles from Telkwa. The property consists of nine claims on the north side of the creek, covering approximately 375 acres."

"The largest of the deposits on the property . . . . was examined . . . . but (it is reported) that other, smaller, similar deposits occur at higher elevations . . . . farther back from the creek. . . The deposit examined, which consists of a sheet of bog iron ore of unknown thickness, extending from the "moss roots" to bedrock, lies on the steep north side of Limonite Creek valley. It extends from the stream . . . . for . . . . 1,800 feet in a straight line up the mountain side . . . from an elevation of 2,600 feet . . . . to 3,500 feet . . . . The irregular area underlain by limonite measures about 2,250,000 square feet, and its greatest width is about 1,800 feet. Everywhere in this area, yellow or brown earthy limonite may be uncovered merely by removing the moss from the surface; there is no overburden except the trees and moss" . . . .

"The deposit consists of bedded bog iron ore . . . . in platy layers from 1 to 3 inches thick, lying parallel to the hill-side, which here

[1] Brewer, W. M.: Rept. of Minister of Mines, B.C., 1914, pp. 123-124.

Index to Localities Represented by Numbers on Figure 2 (pages 18, 19)

1. Summit creek, Zymoetz river
2. Porcher island
3. Stuart anchorage, Pitt island
4. False Stuart anchorage, Pitt island
5. Kumeolon inlet
6. Kitimat river
7. Iron Duke mineral claims, Louise island
8. Apex mountain and Tasu harbour, Moresby island
9. Burnaby island
10. Harriet harbour, Huston inlet, Ikeda bay, and Collison bay; Moresby island
11. Dean channel
12. Evans arm, King island
13. Rivers inlet
14. Seymour inlet
15. Knight inlet
16. Chromium creek, Klinaklini river
17. Nimpkish (Klaanch) river
18. Fanny bay and vicinity, Phillips arm
19. Menzies bay, Vancouver island
20. Iron river, Vancouver island
21. Bacon lake, Vancouver island
22. West Redonda island
23. Sable river, Vancouver island
24. Texada island
25. Alta lake
26. Harrison lake
27. Tipella mountain
28. Lillooet lake and northwest
29. Taseko river
30. Thompson and Fraser rivers above Lytton
31. Glen, Magnet, Moose, and other magnetite deposits
32. Near Merritt and south of Nicola
33. Lodestone mountain
34. Boundary district
35. Franklin camp
36. Near Birchbank
37. Beasley, etc.
38. Pend-d'Oreille and Salmon rivers
39. Near Crawford bay
40. Kitchener
41. Lamb creek
42. Bull river and Sand creek
43. Finger lake
44. Cameron river
45. East Sooke
46. Port San Juan
47. Sarita river and Copper island
48. Sechart
49. Alberni canal
50. Henderson lake and Uchucklesit harbour
51. Kennedy lake and Deer creek
52. Ahousat
53. Hesquiat lake
54. Head bay, Tlupana arm
55. Ingersoll river
56. June group, Quatsino sound
57. West arm, Quatsino sound

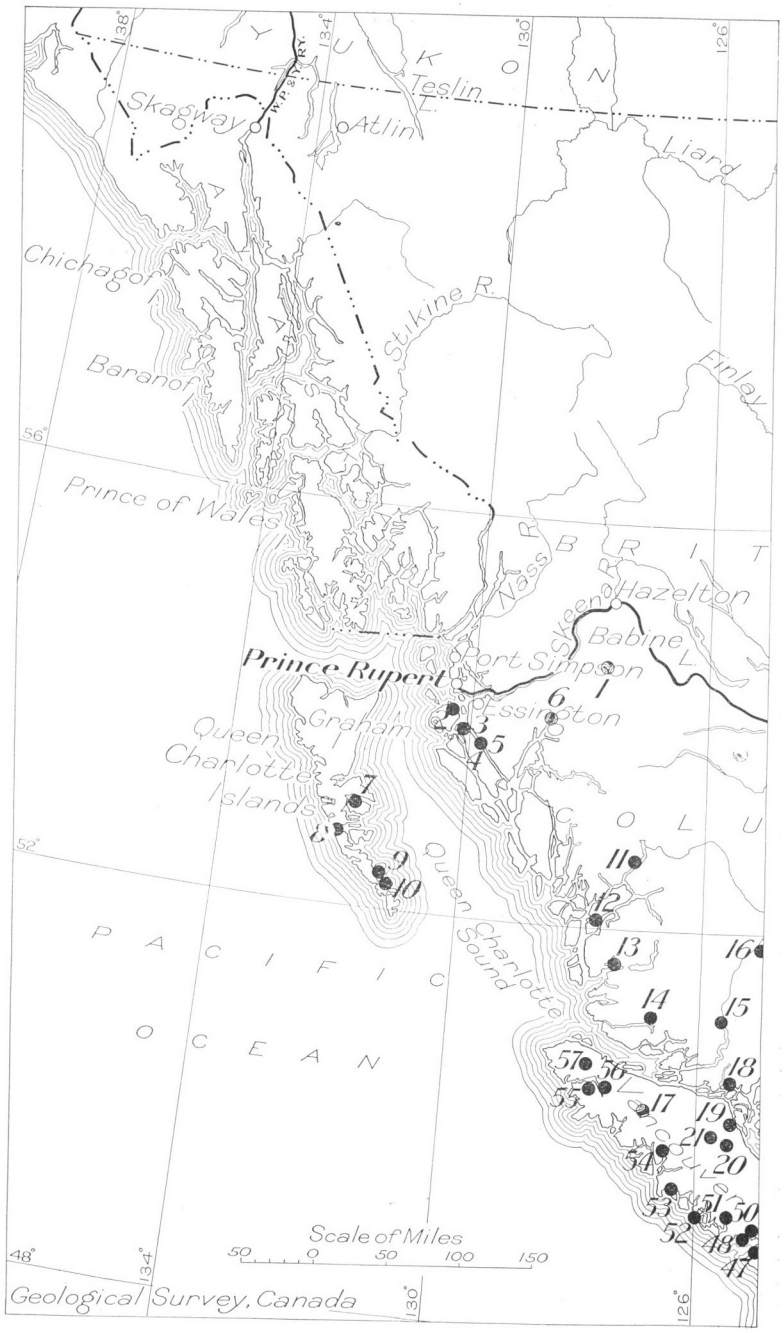
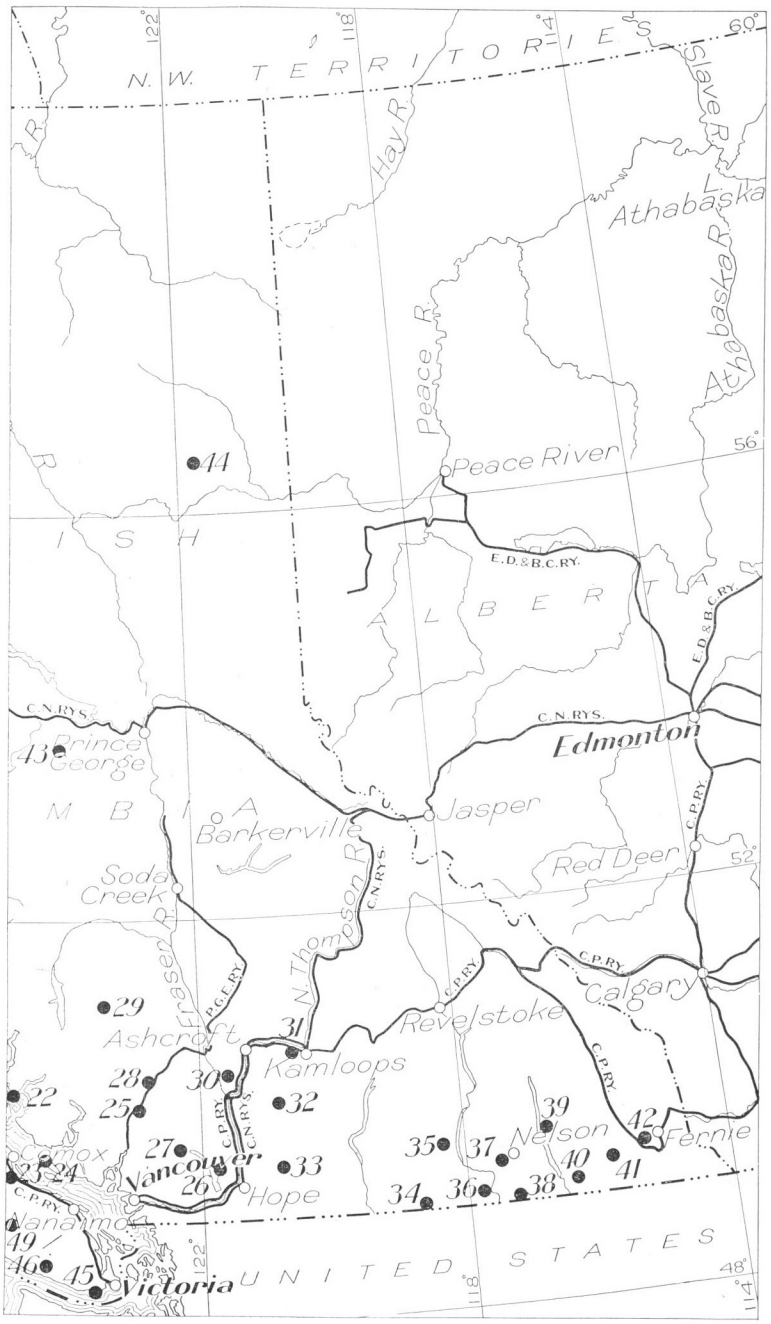


Figure 2. Index map of British Columbia showing positions of iron ore occurrences. (For explan-



ation of locality numbers, *See* page 17.)

has an average slope of nearly 30 degrees. In addition to the stripping of the ore, prospecting has been done by trenching and sinking numerous pits.

The greatest thickness of limonite anywhere exposed is 15 feet; in two or three places 10 feet are exposed, and several cuts show 3 to 4 feet. In no place has the bottom of the sheet of ore been reached" . . . .

"The ore consists of yellow and brown earthy limonite free from . . impurities, rather soft, and of a loose consistency" . . . .

"The country rock on which the ore lies is an altered, greenish porphyry containing in many places, impregnations of pyrite. The writer is informed that on the mountain side above and to the north of the iron deposit are many quartz veins carrying pyrite . . . . Water is constantly flowing down the hill-side . . . . The water flowing over the iron deposit has a strong taste of iron salts . . . . plainly . . . . . derived from the decomposition of iron sulphides farther up the mountain side. This strong solution of iron sulphates . . . . has built up the deposit . . . . by the progressive transformation to limonite of successive layers of moss and other vegetation. . . . . (as) is borne witness by the limonite twigs, roots, chips, fir needles, and cones that have been transformed *partly* or wholly to limonite in the few years since the burned areas were cleared."

"An average depth of 5 feet for the deposit is almost certain; 10 feet is probable and perhaps the depth is greater. In other terms, 562,500 tons may be considered as almost certainly proven; twice that as probable and perhaps the amount is considerably larger. Analyses of the ore are given below:

"Analyses of Ore from North Pacific Iron Mines, Limited

——	1	2	3	4
Iron (metallic)	54·20	56·01	54·32	52·19
Silica (SiO_2)	1·02	0·83	1·99	1·56
Manganese (Mn)	0·85	0·51	0·39	0·70
Phosphorus (P)	0·407	0·016	0·065	0·616
Sulphur (S)	1·16	1·52	1·14	1·47
Water, combined	18·54	16·02	20·47	19·61

Analyses by H. A. Leverin, Mines Branch, from samples collected by J. D. MacKenzie.

1. Sample of a trench wall, from 2 to 10 feet below the surface. Taken by cutting a groove 1 foot wide, 6 inches deep, 8 feet long, and quartering to 8 pounds.
2. A picked specimen representing a 12-inch, harder, more compact band about 2 feet below the surface at the locality of No. 1. . . . .
3. Sample of dump thrown out of a cut. . . . .
4. Sample of dump from a trench. . . . .

"The iron ore is excellently situated for mining, provided transportation could be obtained."[1]

Since the property was examined by MacKenzie, the deposit has been reported upon by privately engaged engineers and in one such report it is stated that an open-cut situated near the centre of the deposit . . . . "exposed a thickness of 22 feet at present, and is said to have a shaft, now (1917) filled up, at the end which showed 8 feet more of ore without reaching bottom." Until the thickness of the deposit has been determined at a number of places any estimate of the ore content may prove misleading, but all available data corroborates the conclusion reached by MacKenzie that at least 500,000 tons of easily mined, nearly pure limonite is present and that it is not improbable that the total is considerably in excess of 1,000,000 tons.

[1] MacKenzie, J. D.: Op. cit.

(2) Porcher Island

LOCATION

Ten or more mineral claims known respectively as Rupert No. 1, Rupert No. 2, etc., have been located on the east side of Porcher island close to the shore of Chismore passage and about 17 miles south of Prince Rupert. The claims are staked along a northwesterly trending line, commence in the south on the slope descending to the bay into which Spiller river empties, and extend northwards for $3\frac{3}{4}$ miles to a point about directly opposite the northwest end of Elizabeth island. Commencing at the point at the north end of the line of claims, outcrops of magnetite occur along or close to the shore for about one-half mile or to the head of a small bay. From the head of the bay a trail leads southward, rising and falling several hundred feet, and passing on the way the various known "showings" of iron ore. These lie one-half mile or less inland from the east coast of the island, in a tract of comparatively low ground which borders the higher country of the interior.

Except for passing references in several annual reports of the Minister of Mines, British Columbia, these mining claims do not appear to have been reported upon hitherto.

GENERAL GEOLOGY

Porcher island lies within the general area of the Coast Range batholith, but as indicated by V. Dolmage,[1] a large part of the island is occupied by the Prince Rupert formation consisting of crystalline schists and limestone presumed to be of Carboniferous or Triassic age. These schists form the country rock in which the iron ore occurs. In the vicinity of the small bay at the north end of the mining claims, various types of schist outcrop as well as a narrow zone of white limestone, which weathers pale yellow. The limestone was seen at intervals over a length of one-half mile with a strike of east 40 degrees south (true) and dipping northeast at an angle varying between 60 and 70 degrees. The limestone occurs in beds up to 10 feet thick with thinner interbeds and layers of nearly dense, dark greenish grey, chloritic schist. The bedding planes and planes of schistosity nearly coincide. To the northeast of the limestone, the rocks are various types of schist, for the most part very fine-grained, chloritic, sericitic, or biotitic, but in part coarser-grained, banded, and siliceous and resembling deformed clastic sediments or granitic rocks.

To the southward rock exposures are comparatively few in the vicinity of the iron ore occurrences which lie in a narrow zone striking southeast approximately parallel to the strike of the schistosity.

DESCRIPTION OF THE ORE OCCURRENCES

The exposures of magnetite occur in several detached groups distributed along a course whose northern part strikes east 45 degrees south and southern part east 55 degrees south. The outcrops of magnetite commence in the north on the eastern shore of what is a small island at extreme high tide, and occur at short intervals along or near the shore for a distance of 2,100 feet. In this distance, eighteen distinct exposures of magnetite were observed within a zone having a maximum width of 200 feet. The

[1] Dolmage, V.: "Coast and Islands of British Columbia between Douglas Channel and the Alaskan Boundary"; Geol. Surv., Canada, Sum. Rept. 1922, pt. A.

outcrops lie in part on the side of a low ridge, in part along the shore, and in part below highwater mark where the rocks are nearly continuously exposed along their strike. The individual outcrops vary in character from a width of several feet of schist bearing films and narrow discontinuous streaks of finely granular magnetite to, in one case, a body of nearly solid magnetite 12 feet thick. In most places rock exposures are sufficiently continuous to indicate that the individual films, streaks, and narrow bands do not continue for more than 50 feet along their strike, which in general coincides with the strike of the planes of schistosity of the enclosing rocks. In places the magnetite streaks, etc., may be seen to die out in a few feet along the strike. At one place a zone of films, streaks, and lenticular bands is exposed at intervals over a length of nearly 200 feet. In places the immediately associated rock is rich in biotite and finely granular quartz, is banded with narrow layers of nearly pure quartz, and others which are dense and chloritic. In other places the rock is dense and carries much finely disseminated epidote and in other cases the country rock is a chloritic schist.

The outcrops of magnetite cease before the head of the small bay is reached. Possibly the magnetite-bearing zone continues beneath the waters of the bay, but since a number of barren rock exposures along the shore and below highwater mark lie on the strike of the magnetite-bearing zone it seems probable that the magnetite is not there developed. South of the head of the bay exposures are wanting for a distance of 500 feet, but recommence on the lower slopes of rising ground and continue southward at wide intervals along the north side of a low ridge. Five hundred feet southeast of the head of the bay, or 1,300 feet southeast of the last magnetite exposure, outcrops of mineralized rocks recommence. They form at least fifteen distinct outcrops in a zone 3,300 feet long and having a maximum breadth of 200 feet. Less than ten other rock outcrops occur along the zone, for nearly the whole country side is drift-covered.

The first outcrops, commencing at the north end, are green, epidotic schists in which are a few stringers of quartz and films and small patches of magnetite developed parallel to the planes of schistosity. Farther southeast at one outcrop the epidotized schist, over an area about 5 feet in diameter, carries magnetite in films, small patches, and small masses up to 1 foot in length and 6 inches in breadth. At another outcrop, still farther southeast, the planes of schistosity in the country rock are corrugated and along one such corrugation, magnetite forms a small body 1 foot thick. Nearby the magnetite occurs in irregular, bed-like bodies fraying out and disappearing in one direction, and in the other uniting into a poorly exposed body of magnetite 4 feet wide and 10 feet long. At this place, as elsewhere, the masses of magnetite, though having the general appearance of conforming to the strike of the schistosity, do in places cut across it at a small angle.

No further exposures occur over a distance of 650 feet to where are outcrops of the usual epidotized and chloritic schist carrying much magnetite in two bands each about one foot wide. Southeast over a distance of 1,800 feet, seven groups of magnetite-bearing exposures occur with only one intervening exposure of barren rock. The various exposures have a general resemblance to one another but differ in detail. Several are so grouped as to give a nearly continuous section across a width of 200 feet. It seems possible that the schists are continuously mineralized over a

length of 2,000 feet and more, but the outcrops are too few and too widely scattered to warrant assuming this to be actually so. It may be that the mineralization is largely confined to comparatively small, isolated areas. The exposures in general consist of epidotized schist-bearing magnetite, or of zones of such rock in green schists. One exposure 40 feet long along the strike and in part 30 feet wide, consists of schist with layers rich in magnetite, the widest of which maintains a width of 2 feet for a length of 30 feet and is nearly solid magnetite with only a few, thin, intermittent partings of schist. At several exposures the magnetite forms two or more bands each several feet wide, and largely composed of magnetite, but with numerous partings of rock; in such cases the neighbouring schists may carry thin, discontinuous films and streaks of magnetite or may be quite barren. In places over a width of several feet, the rock consists of layers of magnetite up to 1 inch in width, alternating with layers of barren rock with an average width twice that of the magnetite bands. In general the magnetite layers conform to the planes of schistosity, but in places depart from this attitude. The individual layers die out along the strike and others take their place at slightly different horizons. The individual layers vary in character from sparsely mineralized rock to nearly solid magnetite which is always very finely granular.

Farther southward along the general strike outcrops are wanting for a space of 1,700 feet, beyond which for a length of 1,300 feet exposures again occur. The most northerly is a green schist with a few films of magnetite and layers several inches wide of a chlorite-magnetite schist. Beyond are exposures in which magnetite in small crystals and accompanied by some pyrite in small crystals is thickly disseminated in a micaceous, siliceous schist over a width of 5 to 10 feet. In places the magnetite forms thin bands, in one case 2½ feet wide, of nearly solid magnetite.

To the southeast, after an exposureless interval of 2,000 feet, light-coloured schists, in part showing much pyrite and a little magnetite, outcrop over a distance of several hundred feet. Beyond this for 4,500 feet no outcrops of mineralized rock are known to occur to where, on the slope to Spiller river, is one exposure of schist in places sparingly mineralized with magnetite either in disseminated grains or aggregated in streaks and thin layers.

MODE OF ORIGIN

The occurrence of the magnetite within a narrow, nearly straight zone striking parallel with the schistosity of the neighbouring rock, the distribution of the magnetite in films, streaks, and bands paralleling the schistosity, the sedimentary character of at least some of the associated rocks, and the fact that wherever observable the planes of schistosity and bedding coincide, are phenomena that might be held to indicate that the magnetite and containing rocks are sediments and that the ore is a bedded iron ore. But since the rock immediately associated with the magnetite frequently is epidotic and otherwise has an altered aspect, and since over a considerable stretch where the iron oxide is coarser it is associated with pyrite, it is thought that the magnetite is secondary and that like most if not all the occurrences of magnetite on the Pacific coast, it is connected in origin with the plutonic rocks of the region. In this instance the magnetite appears to have partly replaced the strata along a narrow, straight zone paralleling the granite contact less than half a mile to the eastward.

ECONOMIC CONSIDERATIONS

Nowhere along the mineralized zone is any large body of magnetite displayed. The largest visible mass of ore is 12 feet thick and this body in a distance of no more than 30 feet decreases in width to less than 4 feet. Much of the magnetite-impregnated material is low grade. The bands of purer magnetite in places may be seen to thin to nothing and wherever the mineralized zone is exposed it is manifest that the individual streaks, patches, and bands of magnetite or magnetite-impregnated rock do not continue far along the strike. The situation at the head of the bay just south of the first described group of magnetite exposures seems unmistakably to indicate that mineralization is lacking along considerable lengths of the general zone. This conclusion is further substantiated by the general lack of exposures along other sections of the zone, for magnetite is resistant to weathering and where it is extensively developed it tends to form elevations which probably would project through the drift covering. The exposures are distributed over a length of nearly 4 miles and the number of the individual exposures is considerable. They possibly present a fair sample of the mineralized zone and if they do, no body of iron ore of merchantable size is present.

(3) Stuart Anchorage, Pitt Island

LOCATION

The Royal mineral claims have been located to include certain outcrops of magnetite on the east coast of the north end of Pitt island. About 7 miles southeast of the head of the island, a short distance south of Stuart anchorage, a low point projects eastward about ½ mile and is penetrated by two narrow bays trending southeast. The mineral location is on the eastern shore of the more easterly of the two bays about halfway to its head.

The iron ore occurrence has been known for some years and was briefly reported upon, in 1915, by W. M. Brewer.[1]

GENERAL GEOLOGY

Pitt island lies within the limits of the Coast Range batholith, but, as indicated by V. Dolmage[2], Triassic or Carboniferous schists and limestone of the Prince Rupert formation occur in the vicinity of Stuart anchorage. Near the magnetite outcrops, the rocks consist of a schistose series in which the planes of schistosity and of bedding nearly coincide and strike southeast. The rocks, save for a few, thin, discontinuous beds of crystalline limestone, consist largely of finely granular, banded quartzoses, biotite gneisses, or schists varying from pale grey to nearly black according to the amount of biotite and other dark-coloured constituents that may be present. The rocks, presumably, are mainly deformed sediments. They are cut, transverse to the direction of schistosity, by dykes of fine-grained granite.

[1] Brewer, W. M.: Ann. Rept., Minister of Mines, B.C., 1914, p. 150.

[2] Dolmage, V.: "Coast and Islands of British Columbia between Douglas Channel and the Alaskan Boundary" Geol. Surv., Canada, 1922, pt. A.

DESCRIPTION OF THE ORE OCCURRENCES

At several places on the jutting point southeast of Stuart anchorage, magnetite occurs in small quantity impregnating parts of bands of micaceous schist, but only in one place does any important amount appear at the surface. At this place a band of mica schist possibly 150 to 250 feet broad forms a narrow ridge which strikes southeast at right angles to the shore and rises along its axis to a height of 100 feet in a distance of 200 feet from the sea. The ridge is largely covered with drift, but rock is exposed at its base at its shore end and over an area a few feet wide and 150 feet long extending from the shore along the northeast side of and close to the axis of the ridge. Several shallow trenches extend from the long rock exposure across the axis of the ridge and two other trenches, respectively 60 and 135 feet distant from the southeast end of the long rock outcrop, cross the strike of the strata. Farther southeast along the ridge a few rock exposures are present.

The magnetite outcrops in several masses at the water edge at the northwest end of the ridge, and is exposed in a band not averaging more than 4 feet in width and which for a length of 200 feet is visible in the long exposure on the northeast face of the hill. Sixty feet southeast of the end of this band of ore and along its strike, no magnetite is visible in a crosscutting trench. Seventy-five feet farther southeast, a second trench shows schist impregnated with magnetite over a width of several feet.

In the case of the several smaller masses of magnetite at the seaward end of the ridge and the long, band-like area, on the northeast slope, although one boundary may be sharply defined, the other usually is not so and for a space of one or more feet the bordering schist is rich in magnetite, or bands of schist and magnetite-rich schist may alternate. The several small bodies at the shore end of the ridge range in length from 15 to 30 feet, and in each case end to the southeast rather abruptly and, possibly, against a fault-plane, though no direct evidence of the existence of a fault was noted. The purer magnetite is compact, fine-grained, with some admixed biotite and other mineral constituents of the schists.

MODE OF ORIGIN

The occurrence of the magnetite in bed-like masses associated with schists of, presumably, sedimentary origin, may suggest that the magnetite also is of sedimentary origin. The sporadic appearance of magnetite elsewhere in the general vicinity and the numerous examples along the Pacific coast of magnetite bodies associated in origin with plutonic rocks, gives rise to the presumption that the magnetite occurrences on the Royal claim also are secondary, and are of the nature of replacement bodies formed along lines of weakness in the more schistose members of the sedimentary series.

ECONOMIC CONSIDERATIONS

The band-like body of magnetite outcropping on the northeast side of the ridge is exposed over a length of 200 feet. At its northwest end it passes below sea-level. At the southeast end it disappears beneath drift. Sixty feet beyond the southeast end, a cross-trench fails to reveal ore; either the band ends in this distance or it has been displaced by a fault.

The smaller bodies of magnetite along the shore at the end of the ridge end abruptly without any direct sign of faulting and it seems probable that the longer band ends in the same way. Further cross-trenching would determine where and how the long band ends and might uncover other masses of magnetite. No evidence was secured that indicates that the outcropping bodies will materially widen either along the strike or dip, or that any concealed bodies will be of greater size than those now visible. The larger, band-like deposit might yield 100 tons of ore for every foot in depth. A body with dimensions such as this could scarcely be mined as iron ore at a profit.

(4) False Stuart Anchorage, Pitt Island

On the northeast side of Pitt island, a short distance northwest of False Stuart anchorage and about opposite the entrance to Kumeolon inlet on the mainland shore of Grenville channel, are a number of exposures of magnetite. These occur close to the shore on a broad, irregular point of land underlain by schistose rocks of the Prince Rupert formation, which a short distance south and inland are cut off by the intrusive granitic rocks of the Coast Range batholith.

At the southernmost occurrence of magnetite, several small strippings close to the shore disclose mica schist with several highly micaceous bands carrying considerable magnetite and occasional streaks of nearly pure iron ore. About 100 yards northwest, a shallow shaft was sunk years ago in a zone of disturbed mica schist with masses, large and small, of garnetite, and small areas of the schist richly impregnated with magnetite. Over a farther distance northwest, of 350 yards, the dark mica schists are visible in places and occasionally carry some magnetite.

Nowhere is any body of iron ore visible. The mode of occurrence is like that of the magnetite masses at Stuart anchorage and farther north on the Rupert claims on Porcher island.

(5) Kumeolon Inlet

Kumeolon inlet is a comparatively small inlet on the east side of Grenville channel, 25 miles south of Prince Rupert. Deposits of magnetite have been reported[1] to occur near the shores of the inlet. No information is available as to the exact position, character, or size of the deposits.

(6) Kitimat River

Kitimat river empties into the head of Kitimat arm, Douglas channel. A few miles up the broad river valley are outcrops of magnetite with varying amounts of chalcopyrite.[2] Private reports have been received which indicate that the deposits so far located should not be considered as sources of iron ore except as a by-product.

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[1] Ann. Rept., Minister of Mines, B.C., 1912, p. 99; 1917, p. 43.

[2] Ann. Rept., Minister of Mines, B.C., 1909, p. 57.

QUEEN CHARLOTTE MINING DIVISION

(7) Iron Duke Mineral Claims, Louise Island

(*See* Figure 3)

LOCATION AND HISTORY

The Iron Duke mineral claim group is owned by Messrs. Rogers, Benson, and Larsen and is situated on the south slope of a ridge rising from the north shore of Louise island. A trail to the claims commences on the south shore of Cumshewa inlet at a low point from which a bearing on the Indian village on the north shore is about north-northwest (335 degrees magnetic). The trail is about 2 miles long, follows a curving course upwards around the east end of a ridge, and ends on the southern slope at the mouth of a tunnel at an elevation of about 1,100 feet.

The property appears to have first attracted attention in 1911; has since changed ownership and was surveyed in 1921. It consists of a number of claims, but work which consists of shallow trenches and a tunnel 69 feet long has been largely concentrated on one claim. The property has been referred to in the following reports:

Ann. Repts., Minister of Mines, 1911, p. 77; 1913, p. 104.

Lindeman E., and Bolton, L. L.: "Iron Ore Occurrences in Canada"; Mines Branch, Dept. of Mines, Canada, vol. 2, p. 18 (1917). The property is referred to twice, once as the Kildoo, Indian Woman, Darling, and Edgar claims, and once as the Cumshewa iron deposits.

Whittier, W. H.: "An Investigation of the Iron Ore Resources of the Northwest"; Univ. of Washington, Bureau of Industrial Research; Bull. No. 2, pp. 68-70 (1917). The amount of ore present above the lowest outcrop is estimated to be 1,610,000 tons.

Clothier, G. A.: "North-western District (No. 1)"; Ann. Repts., Minister of Mines, B.C., 1918, pp. 40-41; 1921, p. 39; 1922, p. 41. Relative positions and the sizes of various exposures of magnetite are given.

Stansfield, A.: "The Commercial Feasibility of the Electric Smelting of Iron Ores in British Columbia"; Dept. of Mines, B.C., Bull. No. 2, p. 31 (1919). An estimate made by B. L. Thane and Company, San Francisco, is that the deposit contains 570,000 tons of iron ore and probably 344,000 tons more.

DESCRIPTION OF ORE OCCURRENCES

The magnetite deposits occur on a steep slope which faces south and is surfaced with a nearly continuous cover of drift, so that natural outcrops of magnetite or country rock are almost lacking. Numerous, short, shallow trenches have been dug, but at the present time, whatever may have been the case originally, only a few of these reach bedrock. The strata appear to be wholly intrusive porphyrites presumably belonging to the widespread Triassic rocks, which in the general vicinity include limestone and other sediments, are cut by numerous dykes, and have been invaded by batholithic bodies of granite, granodiorite, etc., of late Jurassic or early Cretaceous age. The magnetite deposits as indicated more particularly in the tunnel on the property are replacement bodies probably associated in origin with the granitic rocks exposed not far away. No limestone was seen in the immediate vicinity. The magnetite has replaced porphyrites and these rocks close to the magnetite bodies are much altered and have been impregnated with epidote, pyrite, magnetite, garnet, and other minerals.

The exposures of magnetite are almost wholly confined to a zone 360 feet long in an east and west direction with a maximum breadth of 100 feet.

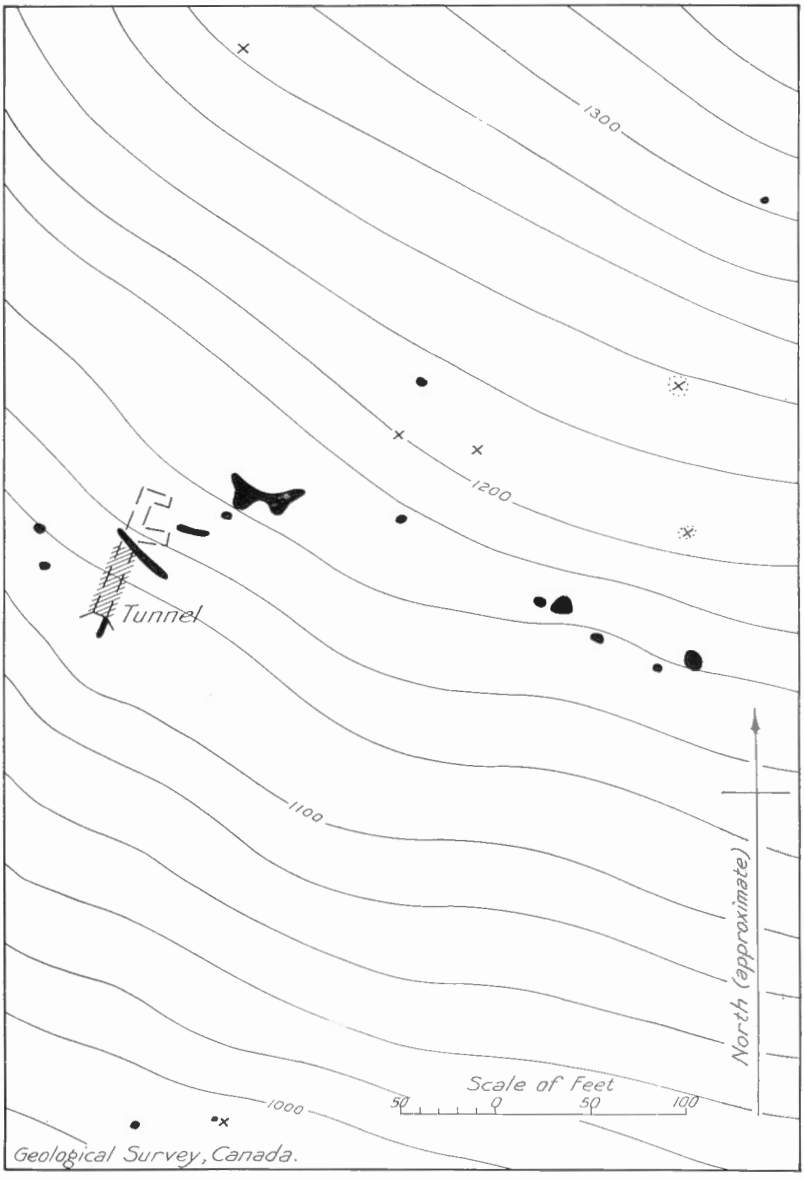

Figure 3. Magnetite deposit, Iron Duke claims, Louise island, Queen Charlotte islands, B.C. Magnetite exposures shown in solid black; magnetite in tunnel by ruling; and altered porphyrite by crosses. Contour interval, 20 feet.

The outcrops vary in dimensions from such as have an area of 2 square feet to one which is 35 feet long and in part 15 feet broad. All the outcrops in this zone are alike mineralogically and consist of rust-stained magnetite which on fresh fractures has a crushed or sheared appearance and may be seen to hold considerable pyrite in scattered grains and aggregates of grains. In spots the pyrite is very abundant and at one outcrop a zone a foot or so wide is largely pyrite.

North of the zone of magnetite outcrops, higher up the hill-side and at a distance of 40 to 150 feet from the zone, are five isolated outcrops of altered porphyrite holding some magnetite and pyrite. Still higher on the slope are two widely separated, small outcrops, one of magnetite, the other of mineralized porphyrite. Two hundred and forty feet south of the zone are two small exposures, one of magnetite, the other of magnetite adjoining altered porphyrite.

The tunnel has been driven in the western part of the zone of magnetite exposures and along a direction approximately at right angles to the trend of the zone. In the open-cut at the tunnel entrance magnetite is exposed on the east side for a length of 10 feet. In grain it varies from fine to coarse and has a sheared aspect. In the tunnel for a distance of 29 feet from the portal, magnetite appears on both walls. The magnetite is greatly fractured and weathered, and much of it is low grade, being intermixed in a very irregular fashion with altered country rock. Pyrite is abundant. At 37 feet from the tunnel entrance on the west side and at 41 feet on the east side, the walls are wholly of altered country rock, the bottom edge of the magnetite body having risen sharply so that the magnetite appears only in the tunnel roof. At this lower contact of the deposit much pyrite is present and the magnetite content is comparatively low. Beyond this point for 28 feet to the end of the tunnel at 69 feet from the entrance, and in two short crosscuts to the east, the walls and roof are of much fractured partly altered rock, irregularly impregnated with pyrite and holding here and there patches and small bodies several feet broad of magnetite.

ECONOMIC CONSIDERATIONS

The exposures of magnetite and country rock are too few to permit of satisfactorily determining the size of the ore-body or bodies. The full significance of the few, small, outlying exposures of magnetite and partly mineralized rock is not apparent. But considering that similar mineralized materials, though not in place, have been reputed to occur over a length of 4,000 feet, it is reasonable to suppose that more than one deposit of considerable size is present. On the other hand it does not seem reasonable to assume, as has been done, that the several isolated exposures 250 feet south of the tunnel and 110 feet below it, together with the outcrops of the zone penetrated by the tunnel and the small, scattered exposures higher up the hill-side, all belong to one ore-body. The outlying exposures may be parts of important deposits, but if so, these deposits can scarcely be continuous with the body or bodies partly exposed east and west of the tunnel.

The six exposures in the immediate vicinity of the tunnel, the outcrop at the tunnel mouth, and the magnetite exposed in the tunnel for a length of 38 feet, presumably belong to one body of magnetite. The outcrops occur within an area 140 feet long in a northeast-southwest direction, 70 feet broad at the southwest end, 30 feet broad at the northeast end,

and with a total difference of relief of 70 feet. Magnetite outcrops at the surface and nearly vertically above country rock in the tunnel where the bottom of the deposit at the point penetrated may be seen to be rising along a steeply inclined plane. The exposure of magnetite immediately above the tunnel is only 30 feet above the inclined base of the deposit and the true thickness of ore at this point is not more than 25 feet. To the northeast, 200 to 300 feet from the tunnel entrance and at a general elevation 100 feet above it, are a few exposures of mineralized country rock. These may represent the floor of the ore-body and if they do its inclination is in the neighbourhood of 45 degrees, and the dip is downhill. The deposit thus has some appearance of being a comparatively thin body dipping southward at an angle of 45 degrees on a surface sloping in the same direction at an angle of 30 degrees. If it be assumed that a ll the outcrops of magnetite exposed in the immediate vicinity of the tunnel and for 300 feet east, belong to one deposit with the above deduced general attitude, and if the exposures at the mouth of the tunnel are near the upper surface of the ore-body, then the total ore content would be 100,000 to 150,000 tons. These figures are considered to represent the maximum amount of ore that may be present. It is conceivable that the actual amount is much less, for the outcrops may belong to two or more ore-bodies and it is not improbable that even if all are part of one body, that much of it would be too low grade to be considered an iron ore. The above figures represent an estimate of the possible ore content of the body or bodies represented by the groups of exposures immediately east and west of the tunnel. Whether the few remaining outcrops of mineralized matter are the outcrops of other ore-bodies or only of mineralized areas of no commercial value, is not known and can only be determined by further prospecting and development work.

(8) Apex Mountain and Tasu Harbour, Moresby Island

Sources of Information. Robertson, W. F.: "Queen Charlotte Islands"; Rept. of Minister of Mines, B.C., 1909, pp. 78-79. Forbes, D. G.: "Queen Charlotte Mining Division"; Rept. of Minister of Mines, B.C., 1913, pp. 96-97, and 99. McConnell, R. G.: "Texada and Moresby Islands, B.C."; Geol. Surv., Canada, Sum. Rept. 1909, pp. 72 to 81.

GENERAL GEOLOGY

Moresby island is occupied by folded and faulted sediments of Triassic age invaded by bodies of dark porphyrite and by masses of granite and various dyke rocks. The sedimentary group includes limestones which are present in fragments . . . . "ranging in size from a few feet to half a mile or more across . . . . (and) are of considerable economic importance, as many of the ore-bodies . . . . have formed in or near them."[1]

(8 a) Apex Mountain

GENERAL DESCRIPTION

The Apex group of claims is situated 1½ miles east of the head of Botany bay, Tasu harbour, on the west coast of Moresby island. The principal showings of magnetite are on Apex mountain on the crest of a ridge with a general elevation of 2,700 feet. At this place the summit of the ridge is of limestone outcropping over a width of 300 feet. On the south slope a short distance below the sharp crest of the ridge, a large

[1] McConnell, R. G.: Op. cit., p. 74.

magnetite lens outcrops, has an apparent thickness of 50 feet, and a length along the outcrop of about 100 feet. At about the same elevation on the north slope and about 400 feet distant measured across the ridge summit, a second, lens-like outcrop of magnetite occurs; this has an apparent thickness of about 60 feet, a length of 125 feet. The two outcrops may be parts of one body which extends north and south for 400 feet or so beneath the cover of limestone, and, as indicated by the two outcrops with a breadth of 100 to 150, and a maximum thickness of 50 to 60 feet.

"The magnetite formed in and replaced a portion of the limestone, near its contact with the granite (exposed lower down the mountain slopes). It includes a number of limestone cores and also small areas made up mostly of garnet and calcspar. It is stained nearly everywhere on the surface with copper carbonates, and in places chalcopyrite is fairly abundant. The copper tenor, judging from the surface exposures, seems important."[1]

"A crosscut tunnel in granite has been driven 50 feet below . . . . (the west side of one of the outcrops) and below the south end of the ore-exposure, for a distance of 200 feet. Considerable exploration work has been done to the west of this crosscut by drifts from it (but no ore was found). . . . (The deposit is) of magnetite and garnetite containing chalcopyrite."[2]

ECONOMIC CONSIDERATIONS

If the magnetite outcrops on the opposite sides of the narrow top of the ridge are parts of one body and if its average dimensions are as indicated by the two outcrops, the deposit possibly contains about 300,000 tons. The probable iron ore content likely is much smaller. The deposit is of the so-called "contact-metamorphic" type and occurs replacing limestone. Like many other examples of this type along the British Columbia coast, the deposit in all probability varies from a mixture of silicates, lime carbonate, sulphides, and comparatively small amounts of magnetite to a grade mainly composed of magnetite. Large masses probably exist too low in iron to be considered iron ore and such masses may occur in any position with respect to the boundaries of the deposit. The probable iron ore content, therefore, is almost certainly much less than the possible content.

(8 b) Tasu Harbour

The Warwick group mineral claims . . . . "are situated south of the entrance to the South arm of Tasu harbour. . . . The principal workings are at an elevation of 1,160 feet above sea-level, and 2,000 feet from it in a direct line. The country rock is a dark, medium-grained, hornblende porphyrite, holding a large inclusion of crystalline limestone. The mineral showings occur partly in the limestone and partly in the porphyrite, and consist of magnetite in unusually large masses, associated with chalcopyrite, pyrite, and pyrrhotite. . . . Besides considerable surface work . . . . a tunnel 100 feet in length (in 1909) has been driven into the main magnetite mass. The tunnel section consists mainly of magnetite, alternating at one point with a band of limestone 15 feet in width and cut by some dykes. Magnetite interbanded with limestone

[1] McConnell, R. G.: Op. cit., p. 80.
[2] Forbes, D. G.: Op. cit., p. 99.

is also shown by surface exposures to extend 100 feet beyond the end of the tunnel. The full length of the ore-body is not yet (in 1909) known. The magnetite is associated with chalcopyrite in grains and bunches, pyrite, and pyrrhotite. The non-metallic . . . . minerals usually accompanying similar deposits are not conspicuous. . . . A second magnetite mass . . . . apparently developed in porphyrite . . . occurs 800 feet northwest of the one tunnelled. It has not been fully defined but is . . . . fully 100 feet in width and 200 feet in length. . . . . Magnetite outcrops, probably marking a line of lenses, are also stated to extend down to the beach."[1]

This deposit, after having been seen in 1913, was described by G. D. Forbes in part as follows.[2] "The surface shows a large deposit of magnetite . . . . exposed on the company's claims for over 500 feet and . . . (traceable) some considerable distance (further) . . . . , dipping to the north at 75 degrees. . . . A tunnel has been driven 300 feet southerly, crosscutting the ore and country rock, the face . . . being in porphyry. In all, the tunnel has cut 134 feet of magnetite ore, in separate bodies, from 4 to 28 feet in width and separated by . . . . dykes and bodies of limestone." . . . A section along the tunnel wall shows nine masses of ore or "mixed ore" separated by stretches of country rock $2\frac{1}{2}$ to 56 feet wide.

From the above descriptions it is apparent that the deposit, by reason of the sulphides present and the many broad partings of country rock, is not an iron-ore deposit. If it were to prove practicable to mine and treat the deposit both for its copper and iron ore content, a large supply of iron ore doubtless would be available.

(9) Burnaby Island

A body of magnetite occurs on a mineral claim, owned by A. Heino, on Burnaby island. The deposit may be reached by a trail which leads from an unnamed bay whose south entrance is Granite point on the southeast shore of Burnaby island. The trail starts from a shingle beach on the north side of the bay about opposite the inner end of a large island. It leads northerly and in a distance of somewhat less than $1\frac{1}{2}$ miles crosses a large stream, and just beyond ends at the outcrop of magnetite at an elevation of about 250 feet close to the foot of the north-facing slope of a high ridge.

About 50 feet below and 100 feet north of the west end of the outcrop of magnetite there is on the trail a small outcrop of rusty weathering, somewhat impure, magnetite. Thirty feet west of this is an exposure of grey, crystalline limestone. The main showing of magnetite consists of a nearly continuous outcrop, 70 feet long in an east-west direction and increasing in width from less than 5 feet at the west end, to 18 feet at the east end. The exposure is on a steep slope and at the east end ranges through a height of 25 feet. The magnetite is nearly pure. Very little garnet is present and only a trace of sulphides. At the west end, the magnetite is overlain by grey, crystalline limestone. At the east end the outcrop is terminated by a fine-grained, igneous rock. The other boundaries of the magnetite exposures are against drift and talus. Eastward

[1] McConnell, R. G.: Op. cit., p. 81.
See also Robertson, W. F.: Op. cit., p. 78.
Forbes, D. G.: Op. cit., pp. 96-97.

along the strike of the magnetite outcrop, at a distance of 100 feet, are fragments of altered, fine-grained, igneous rock and of limestone bearing a little magnetite and possibly lying almost *in situ*, but otherwise, except for the exposures already enumerated, no outcrops of rock or magnetite occur for several hundred yards either east or west along the strike of the magnetite exposure, nor below it over the floor of the valley, nor for a considerable distance above it on the mountain side.

Under the conditions existing it is not possible to form any idea of the possible content of magnetite. The country rocks are the usual assemblage of sediments and intrusive and extrusive volcanic rocks (presumably Triassic) invaded by granite, granodiorite, etc., and cut by numerous dykes. The magnetite body is undoubtedly of the type so common in the general region and has formed by replacing limestone and associated igneous rocks lying close to the edge of a granitic mass. Such bodies are characteristically irregular both as regards their outlines and their mineral composition. Unless the magnetite mass at the surface has dimensions much greater than those indicated by the present outcrops, the total magnetite content scarcely can exceed 10,000 to 30,000 tons.

(10) Harriet Harbour, Huston Inlet, Ikeda Bay and Collison Bay, Moresby Island

GENERAL GEOLOGY

The south end of Moresby island consists of several peninsulas, one of which with an area of about 40 square miles is defined by Huston inlet and Carpenter bay. Many discoveries of magnetite bodies have been made on this peninsula. The general geology of the peninsula is similar to that of Moresby island as a whole and has been described by McConnell[1] as follows. . . . . "The principal sedimentary rocks seen consist of whitish and dark shales and feldspathic sandstones, probably of tuffaceous origin, filled in places with Triassic fossils. The tuffaceous beds are thinly bedded as a rule, and often pass into and alternate with thin beds and bands of greyish limestone. They are usually disturbed and faulted and are cut in all directions by numerous dykes. Massive, greyish limestones . . . . . are widely distributed in small areas, mostly as inclusions in the later intrusive rocks. They were not seen with the tuffaceous rocks . . . . . They are of considerable economic importance, as many of the ore-bodies . . . . . have formed in or near them."

"The most widely distributed rocks . . . . . consist of medium-grained, dark, basic intrusives . . . . . usually more or less porphyritic . . . The more granular varieties resemble diorite. . . . . They are massive. . . . Numerous magnetite lenses have formed in them, often near small inclusions of lime. . . . Greyish granular rocks, mostly granites . . . . . outcrop (in various localities). They are younger than the dark intrusives and probably represent the period of the Coast Range batholith (Jurassic or early Cretaceous). Dark, greyish dykes . . . . . are numerous. . . . They cut all the formations . . . . . and are also found traversing the ore-bodies". . . .

[1] McConnell, R. G.: "Texada and Moresby Islands, B.C."; Geol. Surv., Canada, Sum. Rept. 1909, pp. 72-83.

Magnetite . . . . "occurs in irregular-shaped areas, varying in size from small bunches to great masses . . . . in long vein-like forms, and in grains disseminated through the altered rocks. It is usually associated with iron and copper sulphides, garnet, epidote, and other contact metamorphic minerals. Pyrrhotite is common in most of the magnetite lenses and in the altered areas. . . . Pyrite. . . . is less abundant. . . . Chalcopyrite . . . . occurs in grains and bunches in practically all the lenses. . . . Its distribution in the magnetite lenses is erratic. . . . Garnet and epidote . . . . are present in some quantity in nearly all the mineral occurrences seen. They occur as individuals and in small aggregates. . . ."

"Practically all the mineral occurrences seen are replacement deposits, most of them situated at or near lime-porphyrite or granite-porphyrite contacts. . . . The typical irregular-shaped magnetite lenses grade into long, vein-like forms. These in some instances have magnetite as the principal vein filling, and in others chalcopyrite and the iron sulphides are the chief minerals present. The gangue . . . . consists of the country rock . . . . usually . . . . partially or wholly replaced by secondary minerals". . . .

On the following pages are descriptions of any of the discovered deposits carrying sufficient magnetite to warrant considering them as primarily being iron ore deposits.

(10 a) East Side of Harriet Harbour, Moresby Island

On the east side of Harriet harbour, opposite the south end of the island lying in the entrance to the bay, is a mineralized area in which are small masses of magnetite. This occurence was briefly described by Dawson[1].

The mineralized zone is exposed on the beach and seems to strike inland. A shallow shaft has been sunk on it and it is revealed back from the shore by a trench 150 feet long. Where exposed on the beach the zone is perhaps 80 feet wide and consists of a confused assemblage of various types of fine-grained volcanic rocks, mainly intrusives, with small streaks and masses of magnetite and pyrite-rich patches and small areas of both country rock and magnetite. Inland the zone seems to narrow and where exposed by the narrow trench holds a body of comparatively pure magnetite, 10 feet wide, with well-defined walls dipping at a high angle.

No body of iron ore of commercial value is exposed.

(10 b) Togo Mineral Claim, Harriet Harbour, Moresby Island

LOCATION

The Togo claim is on the slope rising from the west side of Harriet harbour, Moresby island. The mineral occurrences may be reached by following a small stream which reaches the beach at a place from which the bearing on the point on the east side of the entrance to Harriet harbour is north-northwest. The course of the stream is from the northwest. A trail follows its north side to an elevation of 400 feet, there crosses the stream, and pursuing a southerly course strikes a second stream at an elevation of 520 feet. Exposures of magnetite occur on the second stream at an elevation of about 570 feet and about 700 yards from the beach.

[1] Dawson, G. M.: "Report on the Queen Charlotte Islands"; Geol. Surv., Canada, Rept. of Prog. 1878-79, pt. B, pp. 54-55.

GENERAL DESCRIPTION

The property was examined by C. O. Swanson, field assistant, from whose report the following account has been compiled.

Along the bed of the northerly of the two streams are exposures of "greenstone". At an elevation of 160 feet is what may be an outcrop, measuring 3 feet by 3 feet, of magnetite, but possibly is a boulder. Magnetite is reported to have been found in this general vicinity, but no other possible outcrops were seen. At a waterfall on the southerly of the two streams, above the ending of the trail, hornblende-rich diorite is exposed on the two banks of the stream, with, in the stream-bed, a 12-foot band of dark, very fine-grained "greenstone" which extends upwards along the course of the stream. Forty feet above the falls, magnetite is exposed in a zone 2 to 3 feet wide traversing "greenstone," but bounded on one edge, for a few feet, by a small patch of coarsely crystalline calcite which in the form of stringers also extends into the adjoining greenstone. Outcrops of magnetite are traceable eastward nearly continuously for a length of 25 feet and at intervals for 35 feet farther to where the magnetite is represented by an outcrop measuring 2 feet by 3 feet and bordered on two sides by a dark porphyrite. The magnetite appears to occupy an area with an elongated, oval outline striking east-southeast, a length of 60 feet, and a maximum breadth of 12 feet. The body contains much garnet, in places amounting to 50 per cent of the whole. On the west side of the stream bed magnetite with garnet also outcrops and may belong to a continuation of the above-described body or may be the eastern end of another deposit. No other outcrops of magnetite were found in this general vicinity.

The deposit, so far as known, is small and the iron content is low. The occurrence does not appear to be of value as a source of iron ore.

(10 c) Modoc Mineral Claim, Harriet Harbour, Moresby Island

LOCATION

The magnetite deposit on the Modoc claim may be reached by the trail which leads from the southwest angle of Harriet harbour, along the clearing made for a proposed tram-line to the Copper Queen. The trail follows a nearly due south course and 700 feet from the beach and at an elevation of 200 feet crosses a small stream coming from the west. The outcrops of magnetite on the Modoc claim are situated 300 feet up the stream.

GENERAL DESCRIPTION

In the bed and banks of the gully in which runs the stream referred to above, are exposures of fine-grained, dark, igneous rocks much fractured and cut by fine-grained, porphyritic dykes. On the south bank in a small opening is a patch, a few square feet in area, of pyritiferous magnetite with much admixed rock matter. Twenty-five feet farther upstream is the eastern end of a mineralized area 45 feet long and 10 to 15 feet broad. This is occupied by magnetite with masses of country rock, stringers of calcite, and much pyrite which in places over widths of a foot or so forms one-half of the material. In other parts very little pyrite is present.

No other mineralized outcrops were seen on the property. No body of iron ore of commercial quality or size is visible.

(10 d) Reco Mineral Claim, Harriet Harbour, Moresby Island

LOCATION

The mineral deposit on the Reco claim may be reached by the trail which leads from the southwest angle of Harriet harbour along the clearing made for a proposed tram-line to the Copper Queen. The trail follows a nearly due south course and 1,900 feet from the beach and at an elevation of 300 feet crosses a small stream coming from the west. The outcrops of magnetite occur along the sides of the stream depression for a short distance above the trail crossing.

GENERAL DESCRIPTION

For a distance of 200 feet east of the trail, magnetite, usually with very much pyrite and some chalcopyrite, is intermittently exposed on the banks of the gully of the stream referred to above. Most of the outcrops occur on the north bank where the magnetite and sulphides appear as flattened lenticular masses enclosed in shattered, fine-grained, dark volcanic rocks. The largest body appears to be 50 feet long, to dip at an angle of about 30 degrees, and to have a maximum thickness of 10 feet. On the south bank of the gully, magnetite with sulphides is visible at two places.

None of the exposed mineral bodies is rich enough in iron or large enough to be of value as a source of iron ore.

(10 e) Dingo Mineral Claim, Harriet Harbour, Moresby Island

LOCATION AND HISTORY

The mineral deposit on the Dingo claim may be reached by the trail which leads from the southwest angle of Harriet harbour, along the clearing made for a proposed tram-line to the Copper Queen. The trail follows a nearly due south course. At 1,100 yards from the beach and an elevation of 500 feet, a trail leads westerly for 700 feet to the mineral occurrence at an elevation of 800 feet. The occurrence is briefly described in the following publications:

McConnell, R. G.: "Texada and Moresby Islands"; Geol. Surv., Canada, Sum. Rept. 1909, p. 78.

Lindeman, E., and Bolton, L. L.: "Iron Ore Occurrences in Canada"; Mines Branch, Dept. of Mines, Canada, vol. 2, 1917, pp. 18-20. Contained information is derived from the report by R. G. McConnell.

GENERAL DESCRIPTION

The outcrops of magnetite seem to belong to one body which strikes northwest and is bounded by crystalline limestone on the southwest and fine-grained igneous rocks on the northeast. The boundaries appear to be vertical. Near the southeast end the magnetite mass has a width of 15 feet, but along the strike in a distance of 40 feet decreases to a width of less than 5 feet. Beyond this point the deposit appears to continue for a further distance of 25 feet in the form of two diverging and tapering tongue-like extensions 1 to 4 feet broad. The southeast end of the body is not exposed and it is possible that the wider part of the deposit may have a greater length than that assumed, namely 40 feet. But granting that the total length is even twice the exposed length the possible ore content is only a few thousand tons. The exposed ore is of comparatively uniform quality, low in sulphide and with a relatively small amount of garnet and other gangue materials. The contact with limestone is sharp, but with the igneous rocks it is less clearly defined with, in places at least, a border zone several feet wide largely formed of garnet, etc.

(10 f) Magnet Claim, Harriet Harbour, Moresby Island

(*See* Figure 4)

LOCATION AND HISTORY

The Magnet mineral claim is situated 1,400 yards a little west of south of the southwest angle of Harriet harbour, Moresby island. It lies at an elevation of 1,400 feet on the north slope of the ridge separating Harriet harbour from Huston inlet and may be reached by the trail which follows the nearly due south route of what was to have been a tram-line to the Copper Queen property. A little above the workings on this property a branch trail leads westerly to the Magnet claim.

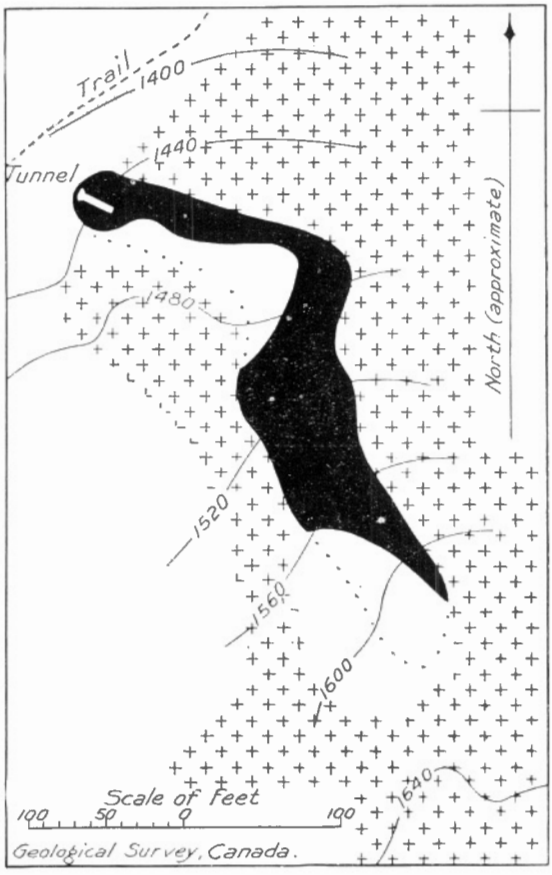

Figure 4. Magnetite deposit, Magnet claim, Harriet harbour, Moresby island, Queen Charlotte islands, B.C. Magnetite shown in solid black; volcanic rocks by crosses; and drift-covered areas are blank.

The mineral claim is owned by J. S. McMillin of Seattle, Washington, U.S.A. Shallow trenches, now in part filled in, have been dug across the trend of the mineral deposit, some stripping performed, and a tunnel 22

feet long driven into the ore-body. The property has been referred to in the following articles under the name of Iron Mountain or Magnet mineral claim.

Robertson, W. F.: "Queen Charlotte Islands"; Ann. Rept., Minister of Mines, B.C., 1907, p. 67.

McConnell, R. G.: "Texada and Moresby Islands"; Geol. Surv., Canada, Sum. Rept. 1909, p. 78.

Lindeman, E., and Bolton, L. L.: "Iron Ore Occurrences in Canada"; Mines Branch, Dept. of Mines, Canada, vol. 2, 1917, pp. 18-20. Contained information has been derived from the above quoted report by R. G. McConnell.

GENERAL DESCRIPTION

In the immediate vicinity of the ore deposit on the Magnet claim the rocks are mainly fine-grained intrusives or extrusives, but one outcrop of dark crystalline limestone was noted. Several hundred yards to the east is the western edge of a large body of granitic rocks.

The ore-body consists mainly of magnetite, but with in places considerable garnetite and included masses of country rock. It outcrops on a slope falling to the north and is exposed over a curving, band-like area 350 feet long and with a maximum width of 75 feet. The mass strikes southerly and disappears beneath drift at both ends. At the southern end outcrops of country rock indicate rather closely the limits of the ore-body in that direction, but at the north end there is a wide, drift-filled depression and nothing to indicate how far the ore-body may extend northward beyond the last outcrops. At the north end the magnetite outcrops on a steep bluff rising 55 feet in an horizontal distance of 30 feet. At the base of this bluff a tunnel has been driven 22 feet southward along the strike of the ore-body. In the tunnel, magnetite is exposed for a length of about 5 feet from the portal, with much sulphide at the boundary between magnetite and the country rock which appears along the rest of the tunnel length, is much shattered, and is traversed by calcite veins. At the tunnel mouth, magnetite outcrops eastward for 20 feet to the boundary of the body and for 12 feet to the west to where outcrops are concealed.

Along the strike of the body, 150 feet from the tunnel entrance, a trench exposes the mass across nearly its full width. Towards the western edge, over a width of more than 30 feet, as exposed in the trench, the ore-body is very largely of garnetite, but on the eastern side, magnetite predominates. On the whole the ore-body at the northern exposures is nearly solid magnetite, but towards the south end the magnetite content decreases and in places the material is not an iron ore. Disseminated sulphide is present everywhere and is abundant in places along or near the eastern margin of the magnetite mass where there are also masses of barren country rock.

The magnetite body has a faintly developed, sheeted appearance and a well-defined parting, both dipping at a low angle to the west. Along the western side of the body the boundary is rarely visible, but in various places country rock is exposed close to the edge and at each place rises higher than the neighbouring outcrops of magnetite. Along the east side of the mass of ore, the country rock wherever exposed lies lower than the adjacent magnetite and in several places may be seen for a few inches to pass beneath it, as also seems to be the case where the tunnel has been driven. Apparently the ore-body is tabular, and dips at a low angle to the westward.

MODE OF ORIGIN

The supposed tabular form of the ore-body and its mineralogical composition, in which garnet plays so important a part, suggest that the mass is a replacement deposit. About 100 feet beyond the northernmost exposure of magnetite there is a small, isolated outcrop of crystalline limestone. It is possible that the magnetite body has replaced an extension of this limestone, together with adjacent parts of the fine-grained extrusive or intrusive volcanic rocks.

ECONOMIC CONSIDERATIONS

The shape and attitude of the ore-body are not definitely known. It is apparent that the whole body is not iron ore, but the available exposures are not sufficient to permit the forming of a reliable estimate of the proportion of ore to waste material. In these circumstances the amount of iron ore certainly known to be present is comparatively trifling.

A small amount of exploratory work would yield evidence which would definitely indicate whether or not the ore-body is tabular, dipping to the west. If, as is believed, this is the shape and attitude the possible iron ore content may be considerable. The relations exhibited at the north end of the outcrops suggest that the floor of the ore-body dips westward at an angle not larger than 30 degrees and that the thickness of the deposit is not greater than 25 or 30 feet. If, making allowances for a considerable northward extension of the body beneath the drift, it be assumed that the higher grade ore occupies a length of 250 feet and has an average thickness of 25 feet, then the ore content for each foot in depth along the plane of dip would be about 750 tons. The depth to which the body may extend cannot be foretold, but may be no greater than the length at the surface, say 250 feet, and the ore content would be, in round numbers, 175,000 tons. These figures are no more than an indication of the possible order of magnitude of the ore-body, because the full length of the ore-body at the surface has not been disclosed, its form and attitude may only be surmised, and the mode of distribution of ore within the mineralized body is unknown.

(10 g) Jessie and Harriet Mining Claims, Harriet Harbour, Moresby Island

(*See* Figure 5)

LOCATION

The outcrops of magnetite on the Jessie and Harriet mining claims occur along the old trail from Jedway on Harriet harbour to Ikeda bay and lie at elevations of 660 to 900 feet on the north-facing slope of a ridge a few hundred yards east of where the trail crosses its summit. They may be reached by following for three-quarters of a mile the new trail from Jedway to Ikeda bay, to where the old trail branches and leads uphill; the outcrops occur at a farther distance of about one-quarter mile along the old trail.

On the summit of the ridge a few hundred feet north of the mineral occurrences on the Jessie and Harriet claims, are outcrops of crystalline limestone and dark, fine-grained, igneous rocks with, perhaps, some altered shales. A short distance down the north slope of the ridge, granodiorite outcrops along the new trail from Jedway to Ikeda. The contact between the granitic rocks and the sediments and volcanics approximately follows the general course of the old trail and the occurrences of magnetite seem to be distributed along or very close to this contact, but rock outcrops are very few in number in the immediate vicinity of the mineralized area.

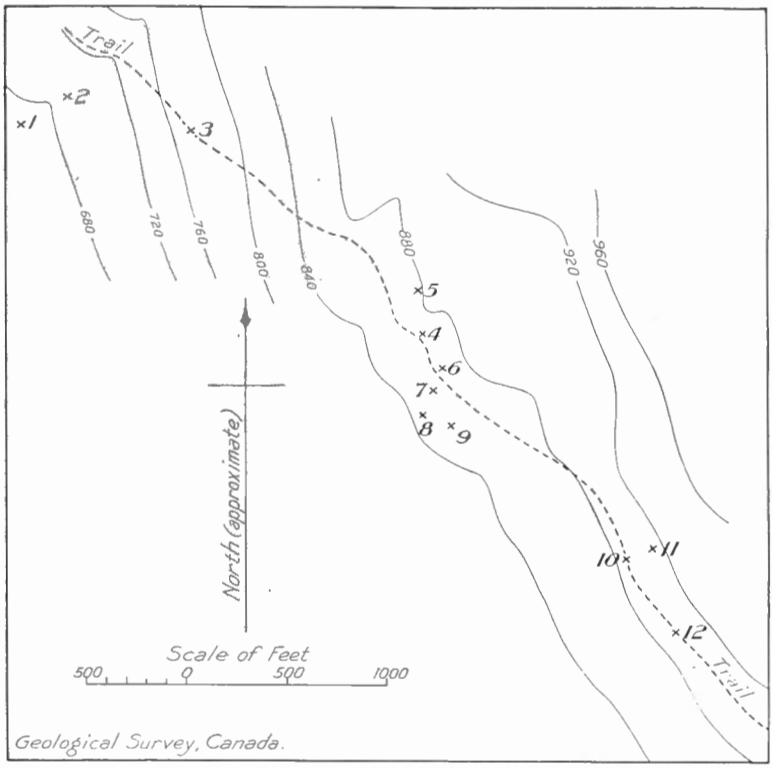

Figure 5. Magnetite outcrops, Jessie and Harriet claims, Harriet harbour, Moresby island, Queen Charlotte islands, B.C. Magnetite outcrops are indicated by crosses and attached numbers (referred to in text). Contour interval, 40 feet.

The known outcrops of magnetite are twelve in number (*See* Figure 5) and occur within a total length of 1,100 feet. Most of them lie within 100 feet of the old trail. Nearly all are small, all are isolated, and in only one instance are the boundaries of the magnetite bodies even partly indicated. The magnetite of nearly all the outcrops is very pure and carries little or no sulphide.

The most westerly exposures of magnetite occur south of the old trail, along a small gully. At this place at locality No. 1 (*See* Figure 5), 125 feet southwest of the trail, a small stream falls over a ledge of grano-

diorite in contact with a mixture of magnetite and garnet cut by a dense dyke. The magnetite-garnetite is exposed over a width of 3 feet and for a length of 10 feet. Below this occurrence granodiorite is exposed at frequent intervals along the course of the stream. Above it are outcrops of a dark, siliceous, altered sediment or volcanic rock and at a place 70 feet south of the trail at locality No. 2 is an outcrop about 15 feet long and a few feet wide of intermixed magnetite and garnet. A third small outcrop of magnetite is visible 15 feet farther downstream. The two last-mentioned outcrops are possibly part of one body having a length of at least 25 feet; its width may be considerably less. Fragments of magnetite occur upstream for some 25 feet, but presumably are from some other, now concealed, source.

One hundred and sixty feet east, at locality No. 3, a small outcrop of magnetite occurs on the trail and much loose magnetite is visible within a radius of 15 feet. Eastward along the trail are several outcrops of porphyrite and of granodiorite and 380 feet to the east at localities 4 and 5, just north of the trail, magnetite has been exposed by stripping over a curving area 110 feet long with a maximum breadth of 15 feet. Fifty feet east of locality 4, magnetite is exposed over an area of 4 feet by 8 feet at locality 6 on the north side of the trail. Twenty-five feet south, at locality 7, stripping has shown the presence of nearly pure magnetite over an area about 25 feet in diameter. Thirty feet farther south, at locality 8, is a magnetite outcrop measuring 4 feet by 6 feet, and 30 feet east of this, at locality 9, magnetite is exposed over an area 10 feet in diameter. Very little country rock is visible at any of the magnetite exposures of localities 4 to 9 which extend over a length of 175 feet with no intervening or nearby exposures of either rock or ore.

East of the above-mentioned outcrops, porphyrite and granodiorite are exposed at a few places on the hill-side. Three hundred and twenty-five feet southeast of locality 6, a small outcrop of magnetite lies on the trail at locality 10. Uphill, 35 feet from this locality, magnetite outcrops at locality 11 over an irregular area 15 feet wide by 20 feet long. At the southeast and northeast angles of this outcrop, country rock is visible, but elsewhere the magnetite passes under drift. Country rock is also visible 20 feet northwest of the magnetite at locality 10 and possibly belongs to the same body as the magnetite at locality 11. If the two occurrences are part of one mass, now largely concealed, it has a length of at least 50 feet and a breadth at one place of 20 feet.

Southeast along the trail, at a distance of 110 feet from locality 10, beyond an exposure of a dense, igneous rock, is an outcrop of magnetite measuring 2 feet by 2 feet. This is locality 12.

ECONOMIC CONSIDERATIONS

The mineral bodies to which belong the various outcrops of magnetite or of magnetite, garnet, etc., have developed along or near the edge of a large body of granodiorite which invades a complex assemblage of sediments and extrusive and intrusive volcanic rocks. The magnetite bodies have replaced the various types of country rock, including the granodiorite. Owing to the scarcity of natural outcrops and the small amount of mining work done, the form and dimensions of the individual magnetite deposits are unknown and no inferences of any value regarding dimensions can be drawn save that all the individual outcrops do not belong to one continuous

body. It is probable, as is known to be the case at many other places, that the individual deposits are irregular in form and composition. The outcrops of localities 1, 2, 3, and 12 belong to as many distinct bodies of quite unknown dimensions. The outcrops at localities 10 and 11 may belong to one mass at least 50 feet long and in part 20 feet wide. The outcrops of localities 4 to 9 inclusive may all belong to one deposit at least 175 feet long and in part 40 feet wide, but it is perhaps more probable that two or more distinct bodies are represented by these outcrops.

The present "showings" may be quite deceptive. Trenching, stripping, and underground exploration might prove that the individual bodies were comparatively small and the available ore reserves insignificant. A small amount of surface work would indicate whether or not any underground explorations were warranted. If the central group of exposures should prove to belong to one body of ore it is possible that several hundred thousand tons might be present.

(10 h) Plunger Mineral Claim, Huston Inlet, Moresby Island

The Plunger claim, owned by Mr. I. Thompson of Jedway, is on the south side of the valley extending eastward from the southeast angle of Huston inlet. It may be reached by following the trail eastward from Huston inlet up the main valley for a distance of $1\frac{1}{4}$ miles to where at an elevation of about 220 feet a faintly marked trail leads southeastward. The branch trail is about 400 yards long and ends at a cabin at an elevation of 580 feet.

Rock outcrops are not numerous in the general vicinity of the claim, but apparently the strata consist of fine-grained, dark intrusive and extrusive volcanic rocks with dark limestone and probably other sediments, cut by light and dark coloured dykes and by bodies of granite. Along the branch trail leading to the cabin on the claim, are several small exposures of highly altered rock, in part garnetite, impregnated with magnetite and various sulphides including chalcopyrite. South of the cabin, at elevations of 680 to 820 feet and at a distance of about 300 feet, is an area 500 feet long by 50 to 200 feet broad in which are a number of exposures of highly altered rock varying from nearly pure garnetite to nearly pure magnetite or magnetite with much sulphide. Some of these outcrops are 50 to 75 feet long, but none is wider than 25 feet. Nowhere is there visible any body of iron ore.

A few yards north of the cabin, magnetite with varying amounts of garnet and other silicates, but accompanied by comparatively little sulphide, outcrops over an area about 80 feet long and 25 feet broad. The outcrops are on the face of, and at the very top of, a steep drop to the south. The magnetite is displayed through a vertical height of about 60 feet. The enclosing rocks where exposed are granite considerably altered close to the magnetite body. Drift and talus conceal much of the mineral deposit, so that its extent and general character are unknown, but the distribution of the various outcrops indicates that in horizontal cross-section the magnetite body is not more than 100 feet long and that its greatest width is not more than 45 feet. Its vertical extent, beyond the known fact that it outcrops through a height of 60 feet, is unknown. The exposures in part are of fairly pure magnetite, but are mainly of magnetite admixed with much garnetite and partly replaced country rock and in places sulphides

are abundant. There is nothing indicating that the body extends more than a few feet below the lowest outcrop and it is possible that the mass has an attitude more nearly horizontal than vertical, that it lies along the irregular upper surface of a granite body at its contact with overlying volcanic and sedimentary rocks, such as are displayed at higher elevations on the mountain slopes several hundred feet to the south. Whether the mineral body has a vertical or more nearly horizontal attitude, the supply of iron ore present is probably not very great. If the mass is pipe-like, extends in a vertical direction, and has the assumed cross-section of 30,000 square feet, the ore supply above the lowest exposure can scarcely much exceed 10,000 or 15,000 tons. For every 100 feet that the body may extend below the lowest outcrop, the content would increase by no more than 35,000 tons. If the mass is lens-like and has an approximately horizontal attitude, the total content might not exceed 25,000 tons.

(10 i) Ida Mineral Claim, Huston Inlet, Moresby Island

The Ida claim, owned by J. S. McMillin of Seattle, Washington, U.S.A., is on the south side of and near the head of the valley which continues in an easterly direction, a large bay in the southeast angle of Huston inlet. The claim may be reached from Huston inlet by following the trail up the main valley to where, about 1½ miles from Huston inlet, the trail reaches the summit of a divide and is joined by a trail from Jedway. The Ida claim is crossed by the trail to Jedway at about 600 yards to the east, where at an elevation of 800 feet a small stream crosses the trail. On the east side of the stream and close to the trail, strippings and natural outcrops expose a mineralized zone striking east of north, and stretching upwards along the axis of a low, narrow ridge on the mountain side.

The mineralized zone is intermittently exposed over a length of 140 feet with no signs of ending in either direction. The exposed width varies from 10 feet to 40 feet, narrowing northeasterly. Rock outcrops are very few in the immediate vicinity of the mineralized body and its limits cannot be defined. Some neighbouring exposures are of medium-grained diorite and granodiorite, and it is possible that the mineral-bearing body has been developed in such rock. Porphyritic dykes cut the mineralized area.

The mineralized zone is largely composed of greenish garnet, with some calcite and other minerals and masses of partly replaced country rock. In places little or no magnetite is present, but a part of the zone with a maximum width of 12 feet and lying toward the southeast edge is rich in magnetite. This part varies from nearly pure magnetite both finely granular and coarsely crystalline, to a granular intermixture of magnetite and garnet with irregular patches of nearly pure garnet. Very little sulphide is present. No large continuous body of magnetite is exposed and the constantly varying nature of the exposed part of the mass does not encourage a belief that any body of iron ore is present.

(10 j) Hercules Mineral Claim, Huston Inlet, Moresby Island

The Hercules claim is owned by J. S. McMillin of Seattle, Washington, U.S.A. It is on the slopes on the south side of the valley which is an eastward extension of a large bay in the southeast angle of Huston inlet. A trail from Huston inlet runs east up the main valley and to the summit of a low divide at its head where a branch trail runs northward to Jedway.

From Huston inlet to the junction of the two trails is about 1½ miles. At a farther distance of 550 yards along the trail to Jedway, a branch trail leads eastward up the mountain side and in a distance of 500 yards and at an elevation of 1,100 feet ends at the workings on the Hercules claim. These consist of two tunnels, one 23 feet long and the other 12 feet long, and several trenches and strippings on a steep slope facing south and broken by several narrow gullies.

The prospecting work has been done within a mineralized area which extends for 150 feet east and west along the slope, has a breadth of 80 feet, and is visible through a vertical height of 70 feet. This general area is only partly exposed and its extent may be somewhat greater than the above figures indicate. It is traversed by a few, dense, unaltered dykes and has been at least partly developed in diorite or granodiorite. It is formed mainly of greenish garnetite with a varying quantity of magnetite, and, locally, considerable coarse calcite, some quartz, and a little pyrite and chalcopyrite. In places magnetite is scarce, in other parts it occurs in streaks and patches, and in several places is fairly evenly disseminated and forms about one-half of the mineralized matter. The material richer in magnetite forms two areas the larger of which measures 20 feet by 60 feet, but for the most part contains too much gangue to be considered iron ore. Even if the larger of the two areas were pure magnetite, the probable amount of ore present would not exceed 10,000 or 15,000 tons.

(10 k) Thunder Mineral Claim Group, Collison Bay, Moresby Island

(*See* Figure 6)

The Thunder group consists of the Thunder, Spade Flush, and Sadie mineral claims, owned jointly by J. S. McMillin of Seattle and I. Thompson of Jedway. They lie on the northwest slopes of the valley which extends southwest from Collison bay. A trail from the bay leads to the entrance of a tunnel on the Thunder claim at an elevation of 600 feet, the Sadie and Spade Flush claims lie northwest at a higher elevation. The Thunder claim has been developed as a copper prospect and no mass of iron ore more than a few feet square has been found on it. Magnetite in considerable amounts occurs on both the Spade Flush and Sadie, but beyond a small amount of stripping and a few shallow trenches no prospecting work has been done on the magnetite bodies.

In the general neighbourhood of the claims, the country rocks are poorly exposed. The few outcrops indicate that the strata consist mainly of dark, fine-grained intrusive rocks with associated masses of limestone. Fine-grained rock types of various kinds are numerous and there are dykes or relatively small bodies of intrusive granodiorite and diorite. The outcrops of magnetite are confined to two areas, each of which lies at an elevation of 1,000 feet on low, spur-like projections on the mountain side. The two areas are separated by a shallow, drift-covered depression 800 feet broad.

The magnetite outcrops on the Sadie claim occur in four groups (*See* Figure 6) on the opposite slopes of a gully 1,300 feet west-southwest of the tunnel entrance on the Thunder claim. At locality 1 (*See* Figure 6) magnetite is exposed over an area 45 feet by 15 feet. At one end of the outcrop considerable sulphide is present. The rest of the showing consists

of vaguely defined masses, a few feet in diameter, of nearly pure magnetite speckled with small grains of garnet, of other masses as large and larger, mainly of garnet or of garnet and magnetite in various proportions, and of occasional small areas of partly unreplaced rock. Twenty-five feet west of the edge of this outcrop is a group of five smaller outcrops lying within an area 50 feet long by 15 feet wide. These smaller outcrops individually carry less than 35 per cent magnetite. They, with th e zed described, comparatively large outcrop, may belong to a single mineralifirst

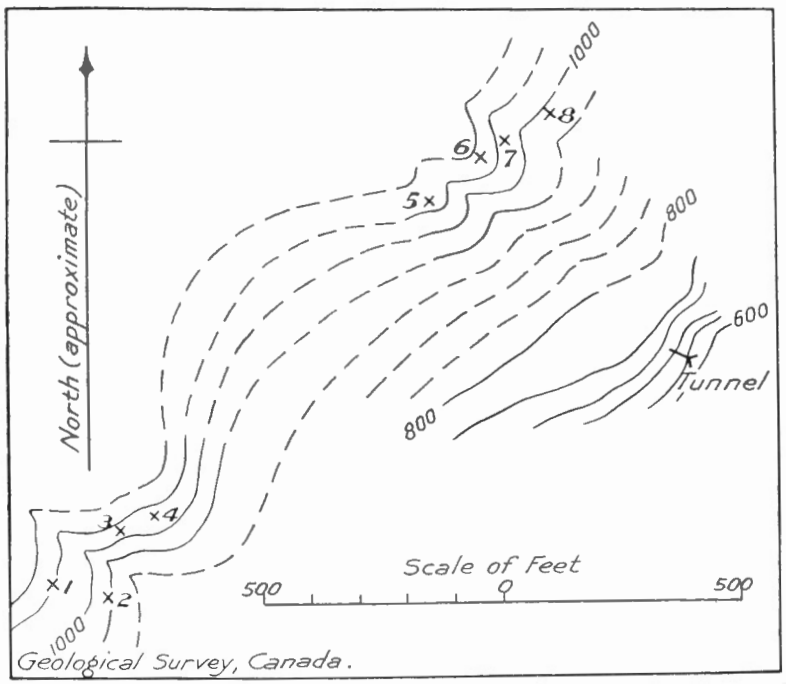

Figure 6. Magnetite occurrences, Thunder claims, Collison bay, Moresby island, Queen Charlotte islands, B.C. Magnetite occurrences are indicated by crosses and attached numbers (referred to in text).

area measuring not less than 65 feet by 50 feet. Rock outcrops are few in the immediate vicinity. Sixty feet west of the westernmost mineralized outcrop are exposures of dark, fine-grained, igneous rocks and 70 feet east, on the banks of a gully, are outcrops of grey, crystalline limestone. A small amount of trenching would suffice to indicate the size of the mineralized area or areas and might give some indication of the attitude of the mineralized body or bodies. It is possible that the garnetite-magnetite forms one or more bodies inclined at comparatively low angles. Though the total amount of magnetite may be large, the magnetite in the visible parts of the mineralized area is not concentrated in large masses.

One hundred feet east and 25 feet lower than the above-described occurrence there is, at locality 2, an exposure of nearly pure magnetite 35 feet long by 5 to 15 feet wide. Only a small amount of garnet is present. Close to the southwest end is a small outcrop of grey, crystalline

limestone. A large group of limestone outcrops lie a short distance north of the east end of the magnetite showing and it seems probable that the body of magnetite has developed along the southeast edge of a limestone mass which may dip to the west at rather low angles.

A few yards northeast of the two above-described occurrences of magnetite and garnetite is a gully on whose western bank is the larger outcrop of crystalline limestone already twice referred to. In the bed of the gully are loose blocks of nearly pure magnetite. A short distance downhill, fine-grained, dark, igneous rock is exposed and the same is visible in several places on the east bank of the gully. It is possible that the mineralized horizon of locality 2 and perhaps also of locality 1, extends northward to the gully and has furnished the loose masses of magnetite there displayed.

One hundred and fifty feet north of locality 2, nearly pure magnetite is exposed in several outcrops at locality 3, along a nearly due north course 60 feet long. The largest individual outcrop is about 10 feet in diameter. A few yards south of the southernmost magnetite outcrop are outcrops of an igneous rock, possibly a dyke; but no other outcrops occur in the immediate vicinity and there is nothing to indicate the possible size of the mineralized area save that, as at the other localities, the trend of the outcrops is north and south as if this was the direction of the longer axis.

Twenty-five feet east of locality 3 are four outcrops, the largest about 10 feet in diameter, of nearly pure magnetite. This is locality 4. The four outcrops lie within an area 80 feet in diameter. To the northeast and north 50 to 100 feet away are several exposures of fine-grained igneous rocks and one of crystalline limestone, but otherwise there is nothing to indicate whether the outcrops of magnetite at locality 4 belong to one or more bodies nor what the size and general character of the body or bodies may be.

At localities 3 and 4 are several small outcrops of garnetite. The garnetite tends to disintegrate, so that at the surface areas rich in magnetite stand out in relief, whereas the lower grade matter forms depressions which tend to be drift filled; therefore, it is possible that the isolated outcrops of both localities belong to one general mineralized area, largely formed of garnet.

The outcrops of magnetite on the Spade Flush claim lie 900 feet northeast of those on the Sadie claim and are separated from them by a wide, shallow, drift-covered depression. The outcrops on the Spade Flush occur on the tops and sides of three knolls. At locality 5, garnetite and magnetite are displayed over an irregular area 80 feet long with a maximum breadth of 35 feet. The outcrops form the southwest and northeast faces and the top of the southeast end of a knoll about 30 feet high. The exposures on the southwest face terminate at a dark dyke at the foot of the slope. On this southwest face the material is largely garnet, but on the northeast face there is an outcrop measuring about 20 feet by 15 feet of nearly pure magnetite. This mass lies within the general area of garnet and intermixed garnet and magnetite. The extent of this area is unknown, for rock outcrops are few. It presumably does not extend to the south more than a few yards beyond the exposures of the dyke rock at the south foot of the knoll; it may continue some considerable distance east and west.

Northeast of locality 5, commencing at a distance of 150 feet, magnetite and garnetite outcrop at three localities, 6, 7, and 8, in a distance of 200 feet. These outcrops are on the sides of two knolls separated from one another by a shallow gully. At locality 6, the southwesternmost of the three, in a length of 30 feet, are two small outcrops, one of garnetite, the other largely of magnetite in contact on one edge with highly altered, fine-grained, igneous rock and on the other edge with a dyke. Immediately northeast of the garnetite exposure is a large outcrop of fine-grained intrusives. Below this outcrop and 30 feet away on the slope of a gully, magnetite is exposed at locality 7 for a length of 50 feet in a north-south direction and with a maximum breadth of 10 feet. At the south end the magnetite body seems to terminate against an area of fine-grained intrusive rocks. The north end is not limited by any rock outcrops. Across the gully from locality 7, 100 feet to the northeast, is locality 8 where several isolated outcrops of magnetite occur over a length of 40 feet and breadth of 10 feet.

ECONOMIC CONSIDERATIONS

The mineralized areas described above present the general characters exhibited by many "contact-metamorphic" deposits of the coast region of British Columbia. Undoubtedly they have formed by replacing country rock near intrusive granitic bodies with which they are associated in origin, although only one small outcrop of granite was seen. Such deposits are characteristically irregular in form and of variable composition. On the Sadie and Spade Flush claims the exposures are not sufficient to determine the outlines of the individual bodies of garnetite and magnetite. At the two general localities the tendency for the individual mineralized outcrops and groups of outcrops to be elongated along a northerly direction is prominent and suggests that the major axes of each mineralized occurrence also strike northward. An impression was also received that the mineral bodies dip at comparatively low angles northwest into the hill-side. The individual deposits may be of the nature of flattened lenses, perhaps in no case thicker than 30 feet. The exposures at localities 1 and 2 in all probability belong to two distinct bodies. The outcrops of localities 3 and 4 may belong to one body, although it seems more likely that they represent two distinct masses. The outcrops at localities 5, 6, 7, and 8 appear to belong to as many distinct bodies and the slight available evidence seems to indicate that bodies 6 and 7 are small.

A comparatively small amount of surface work would be sufficient to indicate the true surface dimensions of any one of the mineral bodies. No reliable estimate of the iron ore content could be formed until some underground work had been performed. A considerable proportion of the present outcrops is of garnet accompanied by comparatively small amounts of magnetite. The iron ore apparently tends to form masses of nearly pure magnetite within the garnetite areas. The number of these masses and their individual sizes cannot be determined from the present outcrops. The amount of magnetite present in the various bodies must be considerable, but it is possible that exploratory work would show that it was largely in the form of comparatively small masses so distributed that mining would not be profitable.

(10 l) Adonis Mineral Claim, Ikeda Bay, Moresby Island

The Adonis claim is crossed at an elevation of 400 feet by the trail from Ikeda bay to Jedway. The outcrops of magnetite are about 1½ miles from Ikeda bay by the trail, commence 20 feet south of the trail, and extend southward, uphill, over a length of 175 feet along a nearly straight course. The difference in elevation between the lowest and highest outcrops is 85 feet. The magnetite as indicated by a series of natural and artificial exposures, occurs in a sharply defined, dyke-like body dipping westerly at a high angle and lying in dark porphyrites such as elsewhere are associated with the Triassic strata. Where exposures of the magnetite are lacking, its existence is indicated by a low, narrow ridge and there can be no doubt that the magnetite body is at least 175 feet long. The width of the body varies between 5 feet and 7 feet, except towards the south end of the line of outcrops where, possibly, it decreases to 2 or 3 feet. The magnetite for the most part is very fine grained and nearly free from impurities. In places a little pyrite is present and small amounts of quartz, garnet, etc. At one outcrop the magnetite body along one edge seemed to quickly shade into the adjoining porphyrite and presumably the whole deposit is of the nature of a replacement.

Unless the magnetite body widens greatly with depth or is much longer than the exposures indicate, the amount of iron ore present cannot be very large. It is possible that the higher and apparently narrower parts of the mass do not represent the end of the body along the strike but along a vertical direction. They may belong to the upper part of the mass. It is reasonable to assume that at least 4,000 tons of iron ore is present above the level of the lowest outcrop. Below that level a body with an average thickness of 5 feet and length of 200 feet would contain 10,000 to 15,000 tons for every 100 feet in depth.

(10 m) Chrysanthemum Group, Ikeda Bay, Moresby Island

(*See* Figure 7)

LOCATION AND HISTORY

The Chrysanthemum group of mineral claims is owned by Awaya, Ikeda, and Company, of Vancouver. The claims lie on the north face of the ridge rising from the south shore of Ikeda bay. A trail leaves the shore of the bay about one-half mile from its head and after ascending to an elevation of about 450 feet, passes close to the principal outcrops of magnetite about one-quarter mile from the shore.

The magnetite deposits have been referred to in the following reports.

Robertson, W. F.: "Queen Charlotte Islands"; Ann. Rept., Minister of Mines, B.C., 1907, pp. 64-65.

McConnell, R. G.: "Texada and Moresby Islands"; Geol. Surv., Canada, Sum. Rept. 1909 p. 77.

DESCRIPTION OF ORE OCCURRENCES

The exposures of magnetite are disposed in several groups in an area about 700 feet long in an east-west direction by 450 feet broad, on the north-facing slope of the ridge bordering the south side of Ikeda bay. Very few rock exposures occur within the area. Those visible are mainly of porphyrites cut by dark, fine-grained dykes. Crystalline limestone occurs in several localities and there are several exposures of granodiorite. The porphyrite and limestone are presumably of Triassic age. The gran-

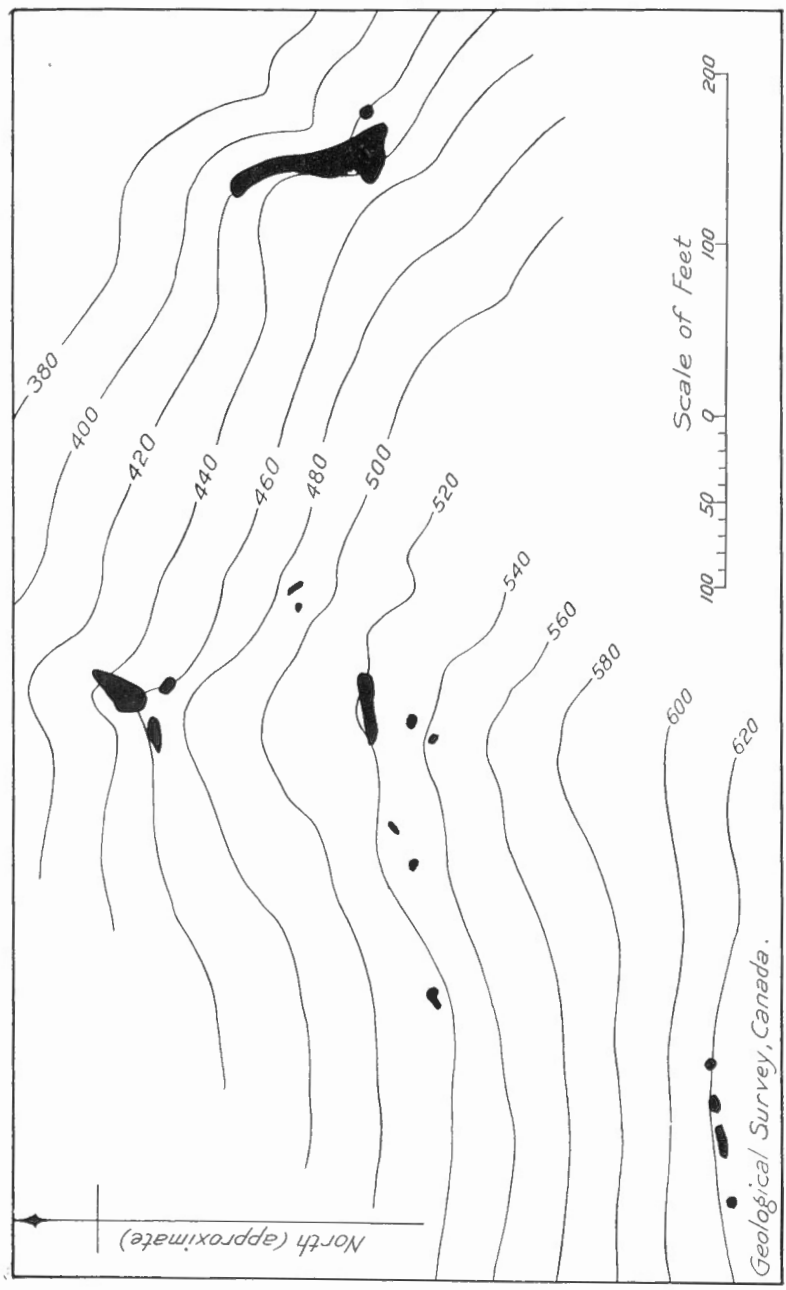

Figure 7. Magnetite deposits, Chrysanthemum claims, Ikeda bay, Moresby island, Queen Charlotte islands, B.C.
Magnetite outcrops shown in solid black.

odiorite is of late Jurassic or early Cretaceous age. The magnetite bodies are replacement bodies doubtless associated in origin with the granodiorite which occupies large areas in neighbouring parts of Moresby island.

The largest single outcrop of magnetite occurs at the east end of the area and lies along the steep east face of a small spur (*See* Figure 7). The magnetite outcrops over a length of 100 feet with a maximum breadth of 30 feet and is displayed through a vertical height of 30 feet. At the north end of the outcrop, the magnetite body terminates against a dark porphyrite. Its southern limit is not closely defined, but apparently lies within 40 feet of the south end of the outcrop, for at that distance south is an exposure of country rock. The west boundary of the outcrop is against drift and no outcrops occur for a considerable distance west. On the east edge of the outcrop a cave runs west into the bluff for 38 feet. The floor of the cave is mainly grey crystalline limestone and the roof magnetite, but the back of the cave is in a dyke rock and limestone appears at two places in the roof in masses dipping westerly at an angle of 30 degrees. The outcrops of magnetite vary from such as are nearly pure magnetite to others largely of garnet and other silicates, or of only partly replaced porphyrite. The mass has the appearance of being a lens-shaped body dipping westerly into the spur at a comparatively low angle. Its maximum thickness appears to be not over 30 feet and its length can scarcely exceed 125 feet.

Two hundred and fifty feet west, in a broad hollow, are two small outcrops of magnetite 10 feet apart. The larger outcrop is about 2 feet high, 10 feet long, and 1 foot broad. The smaller consists of a square foot or so of magnetite exposed beneath a small face of porphyrite. Fifty feet to the northwest is a large exposure of porphyrite. No other outcrops of rock or ore occur nearby. The relations exhibited at the smaller outcrop suggest that the magnetite body dips westerly. No certain indications of its size are apparent.

A few yards west of the above-mentioned outcrops a narrow, spur-like ridge runs north and at its north end are three exposures of magnetite, the largest of which is 35 feet long by 20 feet broad. The three outcrops lie close together and presumably are part of one mass at least 60 feet long. In places the magnetite is exposed through vertical heights of 10 to 12 feet and on the whole carries very little impurities. The northwestern edge of the outcrops is close to the boundary of the magnetite, for within a few feet are exposures of granodiorite or diorite which is also exposed lower down the northwestern and northern slopes. The magnetite body has the general appearance of overlying the granitic rocks, presumably at their contact with the porphyrites. The magnetite body may be of the nature of a comparatively thin lens dipping northwards.

Higher up the slope 125 feet south and on the axis of the same small spur at the end of which occurs the above-described magnetite body, is an exposure of magnetite 45 feet long and in part 20 feet wide. The iron ore is exposed through vertical heights of 5 to 15 feet and is comparatively free from silicates. A few yards away lower down on the western slope are exposures of dark porphyrite. The magnetite body probably is lens-shaped, is not more than 20 feet thick, is not steeply inclined, and rests on porphyrite. Southward, higher on the hill-side, in a distance of 45 feet, are two small outcrops of magnetite. They may belong to another body of magnetite.

To the west in a distance of 160 feet are three small exposures of magnetite. The two easternmost outcrops are 25 feet apart and immediately below them are large outcrops of dark porphyrite. The magnetite is mixed with much garnet, etc., and the outcrops are so small as to suggest that the mineralized body is only a few feet thick. The westernmost of the three exposures is 15 feet long and several feet broad and high. It is partly bordered by porphyrite beneath which it seems to dip.

Another group of magnetite outcrops occurs in the southwest part of the area, 175 feet south-southwest of the last-described outcrop and 110 feet above it. This group is displayed over a length of 75 feet along the slope and over a breadth of 15 feet. The individual outcrops occur almost in line with one another, each outcrop is less than 5 feet broad, and outcrops of porphyrite occur below them a few feet down the slope. The size, outlines, and relative positions of the magnetite outcrops suggest that they all belong to one comparatively thin body, perhaps 100 feet long, which rests on porphyrite but may be steeply inclined.

ECONOMIC CONSIDERATIONS

Each of the larger outcrops of magnetite presents some evidence of belonging to comparatively thin, elongated, lens-like bodies dipping in various directions and at comparatively low angles. The smaller outcrops possibly belong to smaller bodies with the same general habit. If the form of the ore-bodies is such as has been suggested the amount of ore present is not very large, perhaps in no single case exceeding 25,000 tons and combined not exceeding 75,000 tons.

(10 n) Various Mineral Properties in the General Vicinity of Harriet Harbour, Huston Inlet, etc., Moresby Island

Other mineral properties, such as the Copper Queen and Hope, were investigated, but found to show only relatively small outcrops of magnetite with much admixed iron and copper sulphides and various silicates. Such deposits are not iron ore-bodies. The amount of magnetite visible in some cases is impressive at first inspection, but closer examination shows that the magnetite is patchy in distribution and that the single aggregations are only a few yards in diameter and are seldom of even comparatively pure magnetite.

BELLA COOLA MINING DIVISION

(11) Dean Channel

(*See* Figure 8)

LOCATION

A magnetite deposit occurs close to the northwest shore of Dean channel about halfway between the head of the channel and the entrance to Laboucher channel. The position of the deposit is indicated by a small wharf on the north side of a shallow indentation of the coast. The deposit has been known for some years and it has been stated that some 1,200 tons of ore have been shipped to Seattle.[1] The occurrence has been briefly

[1] Clothier, G. A.: Ann. Rept., Minister of Mines, B.C., 1919, p. 86.

described by Dolmage[1] whose map of the region indicates that the upper part of Dean channel is largely bordered by basic schists and gneisses lying in and penetrated by diorite which in this region composes the greater part of the Coast Range batholith.

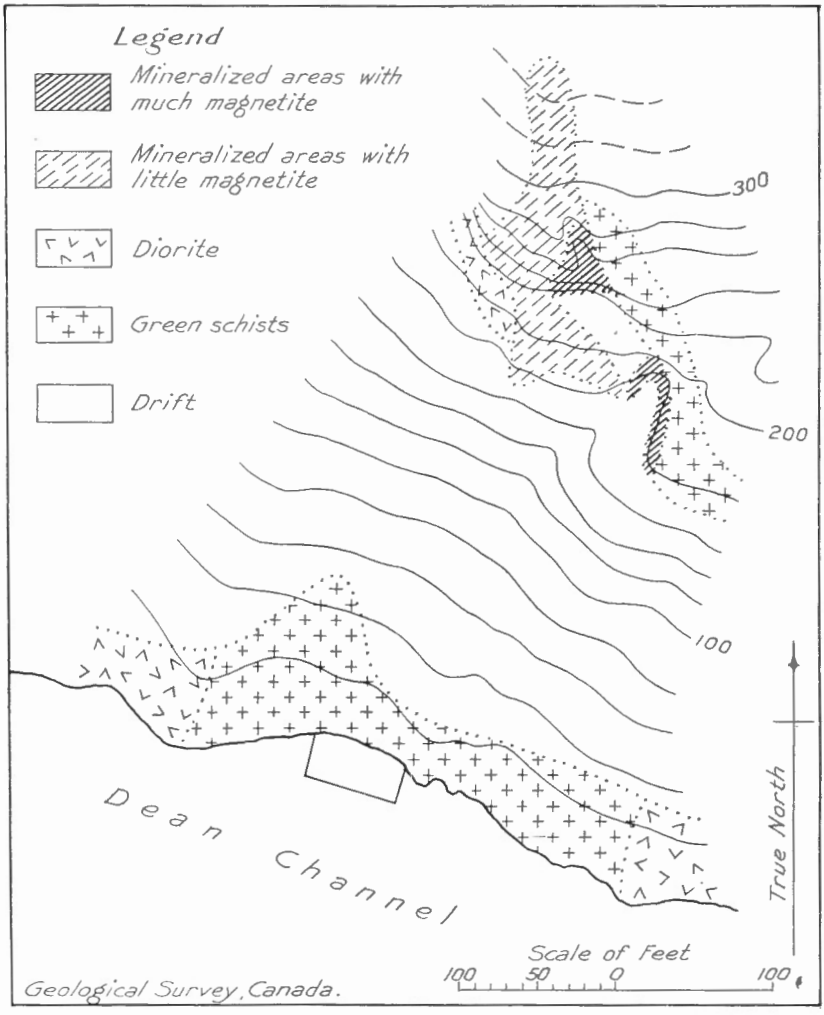

Figure 8. Magnetite deposit, northwest shore of Dean channel, Coast district, B.C.

DESCRIPTION OF THE ORE OCCURRENCES

The magnetite outcrops occur within a few hundred feet of the shore and lie on a steep mountain slope, in an area of dark green, chloritic schists which appear to form an irregular band, several hundred feet broad that extends inland along a general northerly course (*See* Figure 8).

[1] Dolmage, V.: "Coast and Islands of British Columbia between Burke and Douglas Channels;" Geol. Surv., Canada, Sum. Rept. 1922, pt. A, p. 40.

The band of schist lies between intrusive bodies of sheared diorite which on the eastern side occurs over a width of not less than several hundred yards. At the seashore, 200 feet below and 250 feet away from the mineralized area, the schist band has a width of about 300 feet, but a considerable breadth on both sides of the band consists of disrupted masses of schist with intermingled bodies of sheared diorite.

The mineralized area lies in the western part of the schist band and is partly exposed over an oval area 275 feet long and 100 feet broad where widest. Though the mineralized area is on a steep, in part cliff-like, slope, bedrock is largely concealed by natural talus material and by waste rock from quarrying operations that have been conducted on the iron ore deposit. As the accompanying plan (Figure 8) indicates, the full extent of the mineralized area is not exposed. Along its western edge are exposures of sheared diorite and on its eastern border are outcrops of unmineralized green schist. The larger part of the exposed mineralized area consists of (in addition to masses of unaltered schist) areas of the schist traversed by vein-like and more irregular bodies of quartz and of quartz verging on pegmatite. The schists are impregnated with epidote in films, streaks, and larger areas, in places the rock has been converted into a dense garnetite forming patches up to several feet in diameter, and here and there are band-like and irregular aggregations of magnetite. Towards the north end of the mineralized area are exposures in which quartz occurs in masses 3 to 4 feet wide and separated by several feet of schist seamed with magnetite. In the same general neighbourhood the schist, over breadths of 10 to 15 feet, is traversed by closely spaced seams of magnetite varying in width up to several inches.

Along the eastern side of the mineralized zone are two areas in which magnetite is more abundant. The two areas possibly are part of one iron-ore rich zone, but are now separated by a stretch covered by waste rock and talus. At the southern end of the southern and lower of these two areas there has been exposed a body of magnetite 15 feet long with a maximum width of 4 feet. At the north end of the area, in the face of an open-cut, magnetite occurs in irregular masses up to 6 feet in diameter, which lie in a vertical zone 5 to 10 feet wide at the bottom, but narrowing upwards in a few feet to a width of a foot or so. The neighbouring rocks along the west wall of the cut form a confused assemblage of variously altered schist, in part rich in epidote, in part changed to garnetite, with irregular masses and patches of magnetite and traversed by veins of quartz and pegmatitic quartz in places holding biotite crystals. The masses of magnetite, here as elsewhere in the mineralized areas, are fine-grained, almost dense, and form masses of nearly pure iron ore or may have a streaked or banded appearance due to the presence of quartz and of only partly replaced country rock. The iron ore is usually associated with some garnetite carrying streaks of magnetite.

The main body of iron ore is exposed a few yards to the northward and at a higher level. It occurs in a nearly vertical quarry face, 20 to 30 feet high, and on the steeply inclined floor of a rock-cut running from the top of the quarry face into the hill-side. It was not practicable to examine this cut. The quarry face has a width of about 40 feet, the floor is of made ground. At the western end of the quarry face, ore shows along the base and continues eastward for 30 feet. The mass in places rises to a height of 6 feet and appears to dip into the hill at a high angle; its width may be

6 feet and it consists largely of pure, fine-grained magnetite, but with considerable garnetite in places along one or both sides. At the eastern end of the ore mass a body of magnetite rises vertically in the quarry face, it widens upwards from 1 foot to 4 feet, and a branch from it extends west along the rock face and about 20 feet above the quarry floor. A second branch runs easterly for a few feet and apparently rises to the top of the quarry face and extends upwards along the floor of the inclined cutting. In the higher rock cut, the ore, with some interruptions, has a length of 40 feet and an average estimated width of 10 feet. Uphill this band of ore seems to end suddenly, but like the other masses may continue beneath the rock cover.

MODE OF ORIGIN

The deposits belong to the contact-metamorphic class. The ore, in part at least, has replaced the country rock, as is indicated in places by its banded structure with films and narrow streaks and layers of partly replaced schist. But it may be that parts of the ore masses are more nearly like veins, for the bodies of magnetite tend to occur in comparatively narrow forms striking and dipping in various directions. Some of the vein quartz appears to be older than the magnetite, but much is younger. Presumably the ore is associated in origin with the nearby diorite.

ECONOMIC CONSIDERATIONS

Though a considerable amount of iron ore is visible and the ore appears to be of high quality free from any visible sulphides, yet the individual ore-bodies are comparatively small in cross-section and are separated from one another by wide areas of barren rock. The mineralized area is limited in width; its length is less definitely known, but apparently it must end before reaching the shore. Nothing was observed which would indicate that larger ore-bodies are likely to occur either along the strike or at some depth beneath the present surface. In several instances the band-like ore-bodies were observed to end abruptly along their strike and, lacking evidence to the contrary, it is presumed they end as abruptly along the dip.

(12) Evans Arm, King Island

Source of Information. Clothier, A.: "North-western District (No. 1)"; Ann. Rept., Minister of Mines, B.C., 1918, p. 37.

GENERAL DESCRIPTION

Towards the head of Evans arm, on King island, a group of three claims owned by J. A. Pauline and others have been located upon what was considered to be an iron ore-body. According to Clothier[1] there is visible . . . . "a mineralized belt of basic intrusives in the granodiorite, consisting of bands of magnetite, hornblende, feldspathic rock, streaks of quartz, greenstone, etc., some of the magnetite being sparingly mineralized with chalcopyrite. . . . A cross-section of the outcrop 60 feet wide shows 2 feet of magnetite on the foot-wall". . . . In the rest of the section, except for two stretches 10 feet and 3 feet broad, respectively, and occupied by dykes, magnetite occurs in small aggregates. According to this description, no iron ore-body is present.

[1] Clothier, A.: Op. cit., p. 37.

(13) Rivers Inlet

R. P. D. Graham has stated[1] that "in Kilbella bay, Rivers inlet, a patch of limestone in the gneissoid granite includes a seam of massive magnetite . . . . (in which) a shaft had been sunk 100 feet. The width of the magnetite near the shore varies up to about a foot and it is said to have been traced back into the mountain for 1,800 feet". . . .

Dawson[2] states that magnetite has been reported to occur on the west side of Fitzhugh sound near the entrance to Rivers inlet.

Carmichael[3] has stated that . . . . "a body of hematite was reported by A. S. Goring, D.L.S., and said to occur in the vicinity of Rivers inlet . . . . and it is reported that a pit 10 feet deep had been made in it, but it has been found impossible to obtain further particulars of this find, either as to location or quality of the deposit."

(14 a) Kitchener or Haig Group of Mineral Claims, Seymour Inlet

(*See* Figure 9)

LOCATION AND HISTORY

The Kitchener or Haig group of mineral claims is situated on the west side of Seymour inlet about 7 miles from the head of the inlet. The claims occupy part of a point that forms the north side of Wigwam bay. Six claims have been surveyed and are known as, respectively, Haig, Haig Nos. 1, 2, 3, 4, and 5. The owners are stated to be D. H. Martin, Bonthrone Bros., and associates, of Vancouver. A few shallow trenches and a small amount of stripping have been done on various mineralized areas within the claim limits. The only published statements relative to the occurrence and known to the present writer, are the following:

Clothier, G. A.: "North-western District (No. 1)"; Ann. Rept., Minister of Mines, B.C., 1917, pp. 64-5. The occurrences of magnetite are described as belonging to a series of veins.

Stansfield, A.: "The Commercial Feasibility of the Electric Smelting of Iron Ores in British Columbia"; Dept. of Mines, B.C., Bull. No. 2, p. 34 (1919). Contains an analysis of ore from these claims.

GENERAL GEOLOGY

Seymour inlet runs easterly into the Coast range and is bordered by granitic rocks of the Coast Range batholithic area, with here and there bodies of metamorphosed sedimentary and volcanic rocks of uncertain age. The altered sedimentary and volcanic strata have been invaded by the granitic rocks and are remnants of a, at one time, continuous body which covered the granitic material. The plutonic rocks are presumably of late Jurassic or early Cretaceous age. The strata invaded by them may be Triassic.

The interior of the southward-projecting point of land partly covered by the Kitchener (Haig) group of mineral claims is occupied by sedimentary and volcanic strata which form a band about 2,000 feet broad and striking northwesterly. The tip of the point and the main shore at the base of the point are underlain by granodiorite and diorite. The northeast and southwest boundaries of the band of sediments and volcanics pass respectively just within the northeast and southwest limits of the area

[1] Graham, R. P. D.: Geol. Surv., Canada, Sum. Rept. 1908, p. 40.

[2] Dawson, G. M.: "The Mineral Wealth of British Columbia"; Geol. Surv., Canada, 1889, pp. 101 and 151.

[3] Carmichael, H.: "The Iron Ores of the Coast of British Columbia"; Ann. Rept., Minister of Mines, B.C., 1902, p. 206.

covered by the claims. In the vicinity of the boundary the granitic rocks hold large and small fragments of the older rocks and form broad, dyke-like areas within them.

The magnetite occurrences are confined to the area of sediments and volcanics. These rocks for the most part consist of dark, fine-grained mica, and hornblende schists. Several narrow bands of crystalline limestone occur near the southwest margin with a definite northwest strike. Some rock varieties resemble metamorphosed clastic rocks, but presumably the major part is of volcanic types, either intrusive or extrusive or both. Fine-grained dykes are numerous and some are younger than the mineral deposits. The sedimentary and volcanic strata presumably are nearly vertical and in places are contorted.

DESCRIPTION OF MAGNETITE OCCURRENCES

The magnetite occurs in comparatively small amounts at a number of localities which lie towards the middle of the band of schistose rocks and were observed at intervals over a length of 2,500 feet within the limits of the claims and at one place to the northwest of the claims. Within the area of the claims, the mineralized localities lie in a zone with a maximum width of 1,500 feet. Within this zone it is believed that all rock outcrops were examined and that any mineralization of significant amounts was noted. As much of the zone is drift-covered it is possible that important magnetite deposits are present beneath the drift cover. The various magnetite-bearing outcrops are described below in the order of their occurrence from southeast to northwest. The positions of the occurrences are indicated on the accompanying Figure 9.

Occurrence No. 1. An exposure showing magnetite and magnetite-impregnated rock with a total width of 1 to 2 feet and a length of several feet. Seventy feet to the southeast, lower down on the hill-side, a stripping 30 feet by 10 feet holds irregular, discontinuous patches of magnetite, the largest having an area of less than 2 square feet. To the northeast and north, within a radius of 75 feet, the schistose rocks here and there show a few small patches (up to 2 feet in length) of magnetite.

Occurrence No. 2. (250 feet north of No. 1.) An isolated outcrop of magnetite 2 feet in diameter.

Occurrence No. 3. (1,050 feet southwest of No. 2.) A streak of magnetite 2 feet by 6 inches in green schist.

Occurrence No. 4. (900 feet north of No. 3, 650 feet west of No. 2.) An outcrop of magnetite triangular in shape, with sides measuring 10 to 15 feet. About 75 per cent of the outcrop is magnetite, the rest being country rock. Parts are very rusty, due to pyrite.

Occurrence No. 5. (750 feet north of No. 4.) A very little magnetite and pyrite in a short zone not over 1 foot broad.

Occurrence No. 6. (100 feet north of No. 5.) Over a length of about 50 feet along a low cliff face, magnetite appears at intervals in a rusty-weathering schist. The largest single mass of magnetite outcrops over an area of 10 feet by 4 feet in which magnetite and rock are present in about equal amounts.

Occurrence No. 7. (175 feet north of No. 6.) An area 25 feet long by 8 feet broad bears much magnetite in irregular patches in schist.

Occurrence No. 8. (250 feet west of No. 6.) A group of three occurrences. At the most westerly there is a small open-cut, and in this and in the rock outcrop over a radius of a few yards, magnetite with intermixed rock occurs in small, irregular, frayed-like areas. Seventy-five feet northeast, magnetite appears in the face of a stripping 20 feet long. The magne-

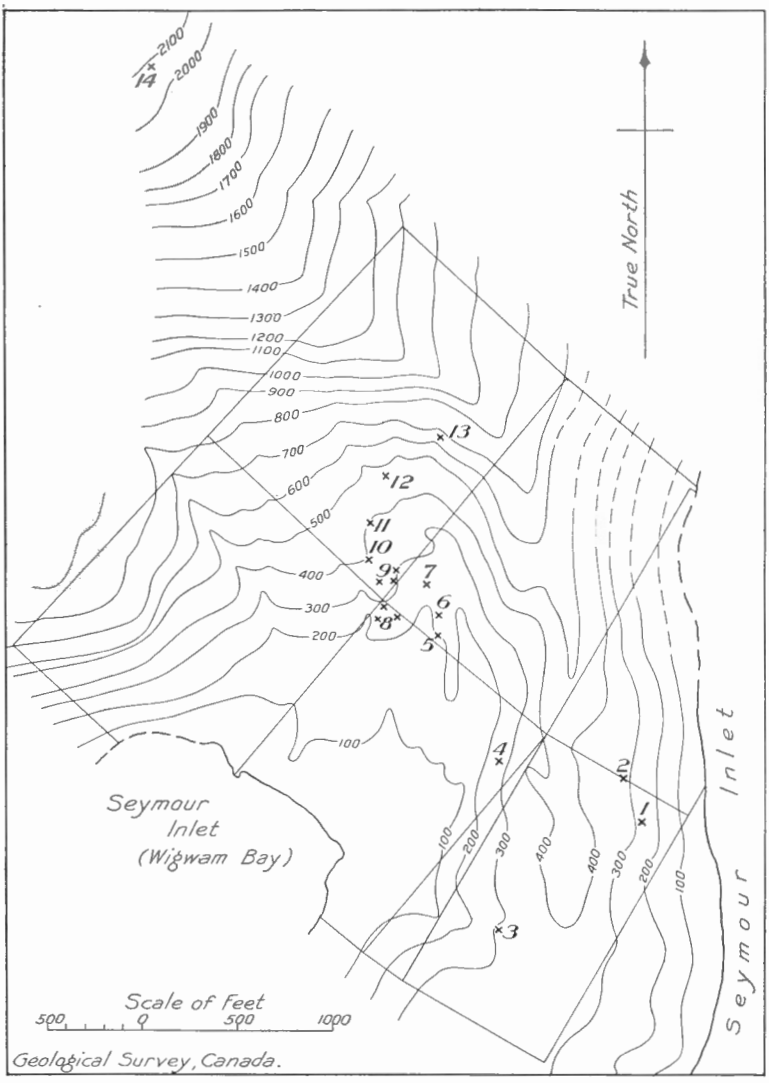

Figure 9. Magnetite occurrences, Kitchener (Haig) claims, Seymour inlet, Coast district, B.C. Magnetite occurrences are indicated by crosses and attached numbers (referred to i text). Contour interval, 100 feet.

tite forms irregular areas, the largest of which measures 15 feet by 3 feet. To the southeast, at the third occurrence of this group, a small excavation has been made in an area of magnetite and magnetite-bearing rock measuring 10 feet by 8 feet.

Occurrence No. 9. (200 feet north of No. 8.) A group of three occurrences. At each of the two eastern localities is a narrow zone 1 to 2 feet wide over which magnetite is disseminated. At the western occurrence, in an area 10 feet in diameter, are streaks and patches, a few inches across, of magnetite.

Occurrence No. 10. (125 feet northwest of No. 9.) Over a length of 10 feet magnetite occurs in a few, narrow, irregular streaks and in patches of 1 or 2 inches in diameter.

Occurrence No. 11. (200 feet north of No. 10.) A narrow streak of magnetite.

Occurrence No. 12. (250 feet north-northeast of No. 11.) An exposure which may be of an erratic, 12 feet by 4 feet, shows considerable magnetite in patches and in a network of vein-like seams.

Occurrence No. 13. (350 feet east-northeast of No. 12.) A body of magnetite 10 feet by 5 feet is here exposed, bordered on one side by a 10-foot zone holding small masses and streaks of magnetite. Along the strike of the single, larger body, at a distance of 17 feet, is a second mass of magnetite 5 feet in diameter. Six feet farther is a somewhat larger body. This zone does not extend much farther along the strike than the above measurements indicate.

Occurrence No. 14. (2,400 feet northwest of No. 13.) This occurrence lies outside of the surveyed mineral claims. At this locality, over a length of 15 feet, magnetite occurs in several irregular bodies, the largest of which may be 7 feet long. The full width is not exposed, but is judged to be a few feet only.

MODE OF ORIGIN

The magnetite of the various mineralized localities is presumed to be associated in origin with the neighbouring bodies of intrusive granitic rocks, although the deposits do not occur at the borders of the plutonic intrusives but towards the middle of the band of schist. Except for a small, variable amount of pyrite, the deposition of the magnetite seems not to have been associated with the formation of any other minerals. The magnetite occurs in narrow, vein-like bodies, in nearly solid masses, in irregular, frayed patches, and as an impregnation of country rock which is a dark schist, usually a hornblende schist. The occurrence at each locality appears to strike at least approximately parallel to the schistosity or banding of neighbouring rocks and the individual masses show a similar tendency. Though narrow streaks resemble veins, the deposits are not veins but are essentially impregnations and replacements of the country rock, which, as might be expected, tended to develop along planes paralleling the schistosity and banding of the schistose strata.

ECONOMIC CONSIDERATIONS

All the known magnetite occurrences are small and for the most part low grade. The largest masses of fairly homogeneous magnetite do not measure over 50 to 75 square feet on their outcrop. Their relations indicate that each mass is a distinct body whose greatest dimension is not more than a few yards. The deposits are not veins, though they tend to occur along the strikes of narrow zones. Larger, valuable bodies of magnetite may occur beneath the drift, but the characters of the outcropping bodies do not favour such a supposition.

NANAIMO MINING DIVISION

(14 b) Alexander Group of Mineral Claims, Seymour Inlet

LOCATION AND HISTORY

The Alexander group consists of three full-size and several fractional claims which have been surveyed and are owned by Mr. Colin Jackson, of North Vancouver, and associates. The claims succeed one another in a southward direction and include the bottom and parts of the bordering slopes of the valley of a stream which enters the east side of Seymour inlet about 5 miles from its head. The stream valley for the first 4,000 feet of its lower stretch follows a nearly straight course slightly west of north. The valley walls for the most part rise precipitously several hundred feet above the valley floor which has a nearly uniform width of 100 feet and rises nearly steadily at the rate of 1 foot in every 2 feet. The valley at its mouth is continued seaward for about 200 feet as a narrow notch in the coast-line.

Considerable stripping has been done on one of the several groups of magnetite deposits found on the claims. One of the mineral occurrences has been briefly described in the two reports listed below, which, so far as known, are the only published accounts of the deposits.

Clothier, G. A.: "North-western District (No. 1)"; Ann. Rept., Minister of Mines, B.C., 1917, p. 65.
Brewer, W. M.: "Western District (No. 6)"; Ann. Rept., Minister of Mines, B.C., 1919, p. 210.

GENERAL GEOLOGY AND DESCRIPTION OF ORE OCCURRENCES

Seymour inlet penetrates in an eastward direction the Coast range which is formed almost exclusively of late Jurassic or (and) early Cretaceous granitic rocks enclosing band-like areas of variously metamorphosed sediments and volcanic rocks which, for the most part, may belong to the Triassic. The floor and walls of the steep, narrow valley traversing the Alexander group of mineral claims are formed mainly of very dark grey, evenly granular, crystalline hornblende and biotite-rich rocks varying from nearly dense to fine and medium grained. The rocks are presumed to be highly metamorphosed sediments and volcanics. They are penetrated by band-like bodies of grey diorite and granodiorite and in places seem to grade into dark, fine-grained diorite. The strata are cut by numerous dark dykes of various ages, some of which are younger than the magnetite deposits.

The observed occurrences of magnetite are five in number. Several others reported to be present were not found, but are mentioned in the following account.

No. 1 occurrence is 400 feet south of the lower end of the valley, at a general elevation of 250 feet, in a narrow gully which breaks the west wall of the main valley. The gully is 10 to 15 yards wide and its floor rises precipitously. A 5-foot, dark, dense, brown-weathering dyke follows the floor of the gully. Along the north edge of the dyke, commencing at an elevation of 240 feet, magnetite outcrops over a length of 15 feet, increasing in width to 12 feet at the west end, where within this width are included "horses" of country rock and also a 2-foot dyke. The westward continuation of the mass is concealed, but it must end within 10 or 15 feet. A few feet to the west, magnetite appears along the south side of

the 5-foot dyke and is exposed for a length of 15 feet with a maximum breadth of 5 feet. This body seems to extend for 35 feet farther, with a width never greater than 15 feet. At its west end the elevation is 305 feet above sea-level. The magnetite thus occurs at intervals over a length of 70 feet and a maximum breadth of 15 feet. Possibly the various outcrops belong to one mass now separated into several by the 5-foot dyke. The deposit varies from nearly pure magnetite to country rock sparingly impregnated with magnetite. It is reported that 100 feet farther along the gully and 150 feet higher, there is a body of magnetite 10 feet by 20 feet.

No. 2 occurrence is 1,200 feet south of the lower end of the main valley. At this place, commencing at an elevation of 560 feet at the foot of the west valley wall, a rust-stained zone, several feet wide and carrying considerable disseminated magnetite, is traceable westward several hundred feet up the steep slopes.

No. 3 occurrence is 1,900 feet south of the lower end of the valley, where at an elevation of 840 feet at the brink of the second falls is visible a 5-foot zone carrying pyrite and magnetite. The iron oxide occurs disseminated and aggregated in small patches. It is reported that several hundred feet farther upstream, magnetite outcrops at two places with widths up to 10 feet.

No. 4 occurrence consists of a number of isolated "showings" along the course of a small stream which, flowing from the west, joins the main stream about 2,600 feet from its mouth and at an elevation of 1,130 feet. Two hundred feet up the tributary stream magnetite is exposed over two areas of several square feet, which lie close to one another on the opposite sides of the stream. One hundred and fifty feet upstream a clearing commences at an elevation of 1,430 feet and extends west up the slope for an horizontal distance of 160 feet and to an elevation of 1,530 feet. A number of bodies of magnetite outcrop over this clearing; their approximate sizes and relative positions are indicated in Figure 10. The most easterly and lowest outcrop is an oval area measuring about 20 feet by 50 feet, stained red at the surface and occupied by magnetite, varying in grain from fine to coarse, with partings of nearly barren rock and much pyrite in disseminated grains and filaments. Forty feet west, higher up the mountain side, is an oval area measuring 10 feet by 15 feet. It is red stained and towards the centre is nearly solid magnetite, but approaching its edges is of rock impregnated with magnetite. Pyrite is comparatively abundant.

Ten feet southwest is a partly exposed body which seems to be triangular of outline and to measure 20 feet by 20 feet. The outcrops are reddish, pyrite is rather abundant, and the marginal parts are of rock impregnated with magnetite. Fifty feet west is a fourth outcrop. It is poorly exposed, but may be circular in outline with a diameter of 17 feet. Twenty feet west are outcrops belonging to a fifth mass which may measure 30 by 45 feet. Twenty feet west of this is a triangular body measuring 20 by 35 feet. This sixth and last group of outcrops may be a part of the fifth mass, for the intervening exposures are of magnetite and magnetite-impregnated rock. There is not a sufficient number of outcrops to permit of definitely determining the limits of the various mineralized areas, but the available information strongly indicates a distribution such as is shown in Figure 10.

No. 5 occurrence lies about 200 feet west of No. 4 occurrence and at an elevation of 1,800 feet. It consists of a red-stained knob of rock 8 feet in diameter, which shows magnetite over an area 5 feet in diameter. Between occurrences Nos. 4 and 5 a smaller but otherwise similar outcrop of magnetite is visible and it is reported that magnetite is or was visible 150 feet south of No. 4 occurrence.

Figure 10. Magnetite outcrops, No. 3 group, Alexander claims, Seymour inlet, Coast district, B.C.

No. 6 occurrence is at an elevation of 1,600 feet in a depression occupied by a small stream coming from the west and joining the main stream 3,400 feet from its mouth. On the tributary stream, commencing 150 feet from its mouth and extending upstream over a length of 100 feet

and a vertical height of 50 feet, magnetite occurs in stringers and small, vaguely defined patches up to 10 or 15 feet in diameter. Parts of the individual masses are nearly pure magnetite, but a considerable proportion of each is only rock impregnated with magnetite.

It is reported that magnetite also occurs a short distance up the main stream above the point of junction of the brook on which lies No. 6 occurrence.

MODE OF ORIGIN

The various occurrences of magnetite are alike in that the individual masses consist of vaguely defined bodies of magnetite grading outwardly through magnetite-impregnated rock into barren country rock. The deposits have formed by replacing the dark, metamorphosed rocks in which they lie and presumably are connected in origin with the plutonic rocks which occupy most of the shore of Seymour inlet.

ECONOMIC CONSIDERATIONS

As sources of iron ore the only deposits of the Alexander group meriting attention are those of No. 4 occurrence, Figure 10. At this place, even assuming that the three most southerly masses form one ore-body, this body would have an outcrop measuring only about 2,500 square feet. On these assumptions its content per foot in depth would be 300 tons, but this figure is certainly much too high, since of the area exposed a considerable part is not ore but rock impregnated with varying amounts of magnetite. The depth to which such a body might extend is problematical. The mass may be pipe-like in outline, but considering that the individual outcrops at all localities tend to be lenticular in outline, and that all the individual deposits have formed by replacing country rock and grade outwardly from a central part relatively high in magnetite to a border zone with a low magnetite content, it is probable that the mass under consideration is of the shape of a lens and that its vertical dimension is of the same order in size as its maximum horizontal dimension, that is 70 feet. In such circumstances the ore content can scarcely exceed 20,000 tons and probably is much less. It is not improbable that the mineralized bodies instead of being vertical dip at a comparatively low angle, in which case if the dip were in the same direction as the slope of the mountain side, the thickness and content of the individual bodies would be comparatively small.

No other mass at locality No. 5 or at the other observed localities approaches in size the above particularly noted mass and, therefore, under present day conditions, do not warrant any consideration as possible sources of iron ore.

(15) Knight Inlet

Richardson[1] many years ago stated he had been informed that iron ore (magnetite?) occurs about 1,200 feet up a mountain side one mile up a river at the head of Knight inlet.

[1] Richardson, J.: "Report on Geological Explorations in British Columbia"; Geol. Surv., Canada, Rept. of Prog. 1873-74, p. 100.

(16) Chromium Creek, Klinaklini River

Sources of Information. Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1916, pp. 166-168
Brewer, W. M.: Ann. Rept., Minister of Mines, B.C., 1921, pp. 218-219.
Dolmage, V.: Geol. Surv., Canada, Sum. Rept. 1925, Pt. A (in press).

GENERAL DESCRIPTION

A number of mineral claims acquired by the Haematite Mining Company of Vancouver have been located on a hematite-bearing area situated at the base of, and on the west side of, Perkins peak, above timber-line. The mountain is at the head of Chromium creek, the main source of Klinaklini river, and may be reached from the east by road and trail from Alexis creek on Chilcotin river. The claims of the Haematite Mining Company, and other adjacent claims, occupy a cirque at the head of Chromium creek and extend down along both sides of the creek. All lie above timber-line.

The district is along the east border of the batholithic area of the Coast Range intrusives. The strata consist of metamorphosed quartzites and argillites, and interbedded volcanic rocks invaded by granite, diorite, etc. The surface of the claims is formed by talus from the bordering precipitous mountain sides. A considerable proportion of the talus material is iron ore in pieces varying in size from gravel to large lumps.

In 1922 the various open-cuts that had been made no longer showed rock in places and a prospect tunnel was no longer accessible.[1] In 1916, when the property was examined by Galloway[2] there were in existence . . . . "eight open-cuts, with a depth of 4 or 5 feet and a length of from 10 to 50 feet . . . . mainly in slide rock. . . . The most westerly cut shows a width of 6 feet of nearly solid hematite." . . . There were several open-cuts along the surface above a tunnel but . . . . "none . . . . show any great width or length of ore, and in most of them it is doubtful if the bottom shows rock in place. All the . . . . hematite (is) mixed with argillite and granitic rock." . . . The tunnel is 600 feet long and . . . . "shows practically no iron ore with the exception of a little near the portal . . . . of a poor grade . . . . much inferior to that" . . . . of the westernmost of the eight open-cuts above referred to. In the tunnel, at 40 feet from the entrance, a winze 18 feet deep follows an " . . . . irregular contact between argillite and granite . . . . (but) no hematite of commercial grade was found. The tunnel continues through granitic rock for some distance . . . ." there penetrates argillite and beyond this for 200 to 300 feet continues in granite and ends in schist.

Galloway is of the opinion that the ore is of . . . . "contact-metamorphic origin . . . . . developed in an argillite rock generally at points not far distant from . . . . pegmatitic granitic dykes . . . . In places . . . . (the hematite) is solid and in others it fades gradually" . . . . to argillite. The hematite replaces the argillite. . . . "At no place is there more than a few tons of ore proven up." . . . . As regards the value of the deposit, there is not . . . . "much proved for or against it."

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[1] Brewer, W. M.: Op. cit., pp. 218-219.
[2] Galloway, J. D.: Op. cit., pp. 166-168.

The following more recent account of the property is by V. Dolmage and will appear also in the Summary Report for 1925, part A. Mr. Dolmage writes as follows:

"A deposit of exceptionally pure hematite occurs in a large cirque on the southeast side of Perkins mountain. It is situated near the bottom of the cirque on the north side at an elevation of 7,500 feet . . . . The hematite occurs in a bed of tuff, which, with other types of volcanic rock, is interbedded with Lower Cretaceous sediments. The tuff bed is 10 to 30 feet thick and is, in places, completely replaced by hematite. Small veins of quartz and specularite cut it and adjoining beds. The beds strike south 70 degrees east and dip 20 degrees south. The contact of the batholith is slightly more than 1 mile to the south. The sedimentary and volcanic beds lying between the hematite deposit and the contact of the batholith are thoroughly impregnated with pyrite, and along certain well-developed shear zones near the iron-bearing tuff, the rocks are completely altered to talc and sericite schists containing a large amount of pyrite.

The dip of the beds in the vicinity of the iron-bearing tuff is low and is nearly parallel to the slope of the surface. This causes the iron formation to outcrop over an area about 100 yards square and to appear to be of much greater extent than it actually is. A large amount of hematite "float" scattered over a still larger area tends to further exaggerate the apparent size of the deposit. A tunnel, now caved, driven in a northerly direction, evidently passed through the hematite near the portal, and was continued for a considerable distance through heavily pyritized talc sericite schist. The hematite bed has been traced along the strike for about 100 yards by a series of large open-cuts and it probably extends much farther. Assuming that it extends an equal distance down the dip, which is quite probable, it is likely that the deposit contains over one hundred thousand tons of exceptionally pure hematite. However, the character of the deposit and the nature of the geological formations enclosing it indicate that it was formed by processes quite different from those which produced the ordinary type of sedimentary iron ore, and would virtually preclude the possibility of its approaching the size of even the smallest of the important sedimentary iron ore deposits. Taking this and the inaccessible situation of the deposit into consideration it is evident that the deposit is of little value at the present time."

(17) Iron Crown Claim, Nimpkish (Klaanch) River

The following account of this property is derived solely from a report by Lindeman[1] which is accompanied by two maps of a part of the property on scales of, respectively, 60 feet and 100 feet to the inch, and presenting the results of a magnetometric survey. On the maps are indicated also the positions and sizes of the outcrops of magnetite.

Nimpkish river enters the southeast corner of Nimpkish lake which is 15 miles long and drains northward by a short river to the northeast coast of Vancouver island opposite Alert Bay. "About 7 miles up . . . . (Nimpkish river from the head of the lake), several claims have been staked, showing much magnetite. The claim of the most

[1] Lindeman, E.: "Iron Ore Deposits of Vancouver and Texada Islands, British Columbia"; Dept. of Mines, 1910, pp. 19-20.

interest is . . . . (the) Iron Crown . . . An exposure of magnetite extends along the face of the river bank for some 180 feet. The height of the bank is about 80 or 100 feet, forming at some points cliffs of magnetite 25 to 30 feet high. . . . Farther up the hill, about 650 feet from the river, several outcrops of magnetite occur along the ridge. . . . The solid formation being effectively covered by a sandy loam and a heavy vegetation, the outcrops mentioned were all that could be seen. . . . (The results of a magnetometric survey combined with the distribution of the observed outcrops indicate in the case of the magnetite occurrence along the river bank that the width of the body) at the west end may be estimated at not less than 100 feet. The length . . . may be assumed to be about 190 feet. . . . (The deposits outcropping along the ridge, back from the river, are) the most important and may be assumed to consist of two, possibly three, ore lenses. . . . (The largest) . . . . has a length of at least 380 feet; a width of 60 feet is very probable, and in some places, it is even greater. . . . (The existence of a third group of ore-bodies, lying on the slope below the last mentioned, is indicated by the magnetometric survey, but this mass) is altogether covered by soil. The magnetic curves show . . . . the ore strike to be about parallel with the former group, with a length of about 480 feet, and a width which, in places, may be assumed to be very little less than (60 feet). . . . As far as surface indications go, the claim may be said to be one of the best iron prospects on Vancouver island."

On the map accompanying the report by Lindeman, magnetite ore is indicated as outcropping within 100 feet of the river, in three places in a length of 150 feet along an east direction. The second group of outcrops, according to the map, lie 500 feet south-southwest of those closer to the river, and consist of eight individual outcrops, distributed over a length of 380 feet trending southeast, and a breadth of 100 feet.

The district is known to be at least partly occupied by an assemblage of volcanic and sedimentary rocks, including limestone, that are invaded by large and small bodies of granite, granodiorite, etc. Though Mr. Lindeman's report makes no further reference to the mineralogical composition of the ore than as given in the above excerpts and makes no reference to the rocks displayed anywhere in the general vicinity of the claim, it is highly probable, if not almost certain, that the magnetite deposits of the Iron Crown claim are of the contact-metamorphic type so widespread along the Pacific coast. That is, they are presumably replacements of volcanics or of sediments or of both kinds of rock. The masses probably vary from nearly pure magnetite to low-grade mixtures of various silicates. It is possible that the few outcrops are a measure of the amount of ore (as distinguished from low-grade mixtures of silicates and magnetite) present, because the masses of more nearly pure magnetite are more resistant to weathering than the mixtures of magnetite and silicates and, therefore, tend to stand out in relief on the rock surface and, consequently, tend to form most of the exposures in drift-covered areas.

No reliable estimate of the amount of ore present can be formed from the available information. If only half of each of the mineralized areas outlined by the magnetometric survey are composed of iron ore as distinguished from low-grade mixtures of magnetite, silicates, and country rock, then the amount of ore present would, in all probability, be at least 100,000 tons and the total might be much greater.

(18) Fanny Bay and Vicinity, Phillips Arm

(*See* Figure 11)

LOCATION

Phillips arm is one of the shorter fiords penetrating the mainland coast of British Columbia. It lies between Bute inlet on the east and Loughborough inlet on the west, is 135 miles northwest of Vancouver, opens into Cordero channel opposite Shoal bay, and is 5 miles long. Near its head, on the west side, is Fanny bay, a narrow body of water less than a mile long and running northwest. From the head of the bay, a narrow valley extends inland, and on its southwest side, about a mile from tidewater, is the Shoo Fly mineral location on which bodies of magnetite occur. On the opposite, northeast slopes of the valley, nearer the head of the bay, magnetite has been discovered on the Iron Duke mineral location and is reported to occur also on the high ridge rising on the north side of Fanny bay and again on the slopes and summits of a mountain rising from the east side of Phillips arm nearly opposite but a little north of the mouth of Fanny bay.

The ore outcrops on the Shoo Fly claim may be reached by following a partly overgrown path and lumbering road which leads up the valley and leaves the head of Fanny bay in the rear of a shack on the shore. The workings are at an elevation of about 1,100 feet, not far below the summit of the ridge on the southwest side of the valley. They lie opposite a point on the lumber road several hundred yards beyond where it crosses a stream or at a distance of about three-quarters of a mile from Fanny bay.

The magnetite occurrence on the Iron Duke claim on the north side of the valley nearer the head of Fanny bay lies at an elevation of about 1,450 feet and on the west side of a steep gully. To reach the ore outcrop it is advisable to follow an old, overgrown skidway which starts from the north shore of Fanny bay near its head. After reaching the gully above referred to, it should be crossed and followed upwards along its western brink.

HISTORY

The earliest published reference to the Shoo Fly claim appears to be contained in the Annual Report for 1901 of the Minister of Mines of British Columbia, where it is stated that the claim has been bonded and "is being worked for its iron ore." Apparently this work was for a time energetically carried on, for two tunnels have been driven, one 100 feet long and the other 73 feet long, and an ore chute, designed to carry the ore to the shore of Fanny bay, is reported to have been erected. No ore is known to have been shipped.

The mineral location on which the magnetite showing occurs on the west side of the valley belonged in 1922 to P. MacDonald of Shoal Bay and had been staked several years previously. The other occurrences along the north side of Fanny bay and on the slopes of the mountain on the east side of Phillips arm, facing Fanny bay, have been staked and possibly restaked at different times, but no serious work has been done on them.

Save for passing references to the iron ore occurrences, the following are the only published references that have been noted.

Ann. Rept., Minister of Mines, B.C., 1901, p. 1,103. Contains a statement by the Gold Commissioner to the effect that mining operations are being conducted on the Shoo Fly claim.
Stansfield, A.: "The Commercial Feasibility of the Electric Smelting of Iron Ore in British Columbia"; Dept. of Mines, B.C., Bull. No. 2, p. 34 (1919). Contains a generalized statement regarding the Shoo Fly claim, based on unpublished reports of several engineers.

GENERAL GEOLOGY

Phillips arm lies within the area of the Coast Range batholithic rocks which in general vary in character from granites to gabbros and give evidence of belonging to a succession of intrusions. In the general vicinity of Fanny bay, slates and limestones are present in considerable volume in the form of bands up to one mile in width, extending in a general northwest-southeast direction and in some instances continuing along the strike for distances of several miles. Besides these larger, band-like areas, smaller masses of sedimentary rocks are common and all are cut and penetrated by the granitic rocks and are traversed by dykes of various kinds. These masses of sediments are presumably remnants of the cover that once overlay the granitic rocks.

The limestone and other sediments occupy both shores of Fanny bay and extend upwards towards the summits of the bordering ridges. The strata strike inland up the valley continuing the bay, but at a short distance inland are partly or wholly cut off by invasions of granite and diorite. Similar strata occur on the east side of Phillips arm opposite Fanny bay, but there, too, are embayed by the plutonics and several miles inland seem to be terminated by a body of dioritic rock.

DESCRIPTION OF THE ORE OCCURRENCES

On the Shoo Fly mineral claim, two tunnels have been driven in a southerly direction into the ridge rising on the south side of the valley. West of the workings, the slopes of the ridge appear to be underlain by diorite and more acid phases of the rock approaching granite in composition. In the vicinity of the tunnels, grey, crystalline limestone outcrops, forming a band 100 feet broad, striking up hill diagonally in a southeasterly direction, and bounded on both sides by a basic phase of the diorite or by altered rock presumed to represent the diorite (*See* Figure 11). Higher up the slopes the limestone area broadens and it possibly occupies a considerable area on the summit of the ridge. Along the contacts of the limestone with the invading diorite, garnetite has developed in places and on or near the southwest contact magnetite is exposed in several places. Possibly iron ore is developed elsewhere along the contact of the diorite and limestone, but if so it is concealed by the general mantle of drift. One mineralized outcrop is 80 feet west of the entrance to the lower tunnel and at the same elevation. At this point a zone 8 to 10 feet wide consists of altered rock, apparently not limestone, carrying much disseminated magnetite and considerable pyrite. At one edge fairly pure magnetite forms a body several feet wide. The country rock appears to be diorite cut by a grey dyke rock. A second outcrop of mineralized rock is 60 feet higher than the entrance to the lower tunnel and is situated directly over a point in the tunnel 50 feet from its mouth. At this occurrence magnetite is abundantly developed over a vertical rock face 20 feet high, of garnetite

representing limestone at its contact with the diorite. Similar material outcrops at intervals to the southeast over a length of about 40 feet. This zone crosses over the upper tunnel.

The lower tunnel is 100 feet long and penetrates grey crystalline limestone, until at 59 feet from its mouth a mineralized zone is encountered which extends for 39 feet or almost to the end of the tunnel which ends in a confused assemblage of granite and diorite. This mineralized zone commences in the tunnel 10 feet farther from the tunnel mouth than the outcrop of magnetite on the surface 60 feet vertically above it. The major part of the mineralized zone lies in diorite. At 59 feet from the tunnel mouth the limestone is abruptly succeeded by a mass of fairly pure magnetite having a thickness of about 4 feet. This is succeeded by a fine-grained, greenish dyke 6 feet thick. Beyond this for 21 feet the tunnel penetrates a greenish dioritic rock heavily impregnated with magnetite, much of the matter being first-class iron ore. This zone is succeeded by a greenish dyke about 3 feet thick, beyond which is a zone several feet wide of basic diorite heavily mineralized with sulphides, including pyrrhotite and chalcopyrite. The remaining few feet of the tunnel are cut in diorite. The dykes observed in the tunnel trend parallel to the diorite-limestone contact and similar dykes are observable along the surface with the same general trend and relative positions, thus rendering it probable that they are a constant feature within the mineralized zone both along the strike and in depth.

The entrance to the second tunnel is 60 feet southeast of the first and 55 feet higher. The second tunnel is 73 feet long. It ends in diorite penetrating, first, 45 feet of limestone, then a fine-grained, greenish dyke for 6 feet, then 17 feet of garnetite, and finally 5 feet of dioritic rocks. Near the face, an irregular body of magnetite carrying considerable pyrite and having a thickness of 2 to 4 feet lies in the garnetite along the contact of this rock with the diorite.

In the Iron Duke claim on the north slope of the valley, magnetite outcrops on a broken hill-side rising with an average angle of 45 degrees. A short distance down hill are exposures of granite; in the vicinity of the ore outcrops, the rocks are dense, black, dark green and pale grey sediments and volcanics. The lowest ore outcrop occurs in a ledge close to the west brink of a gully. At this point, in a 5-foot face, magnetite forms two bodies, one 30 inches thick, the other 20 inches thick, and separated from one another by 20 inches of barren rock. The ore is fairly pure and sharply separated from the adjoining country rock. Both the ore and country rock are much fractured and slickensided and thin films of sulphide occur along some of these partings. At a point distant 35 feet both horizontally and vertically from the first exposure, a rock face shows a zone of ore 3 feet wide and traceable through a vertical distance of 15 feet. A third ore outcrop occurs 35 feet higher on the slope and 45 feet distant, horizontally, from the second outcrop. At this place, on a vertical rock wall, magnetite outcrops through a height of 15 feet with a maximum width of $4\frac{1}{2}$ feet. This body is not in line with the other two occurrences, does not seem to extend up or down hill beyond the area exposed, and perhaps extends laterally into the hill, but with a true thickness considerably less than its apparent width of $4\frac{1}{2}$ feet. The two lower magnetite bodies may join one another, but whether this is so or not can not be determined until some stripping has been done. The lowest

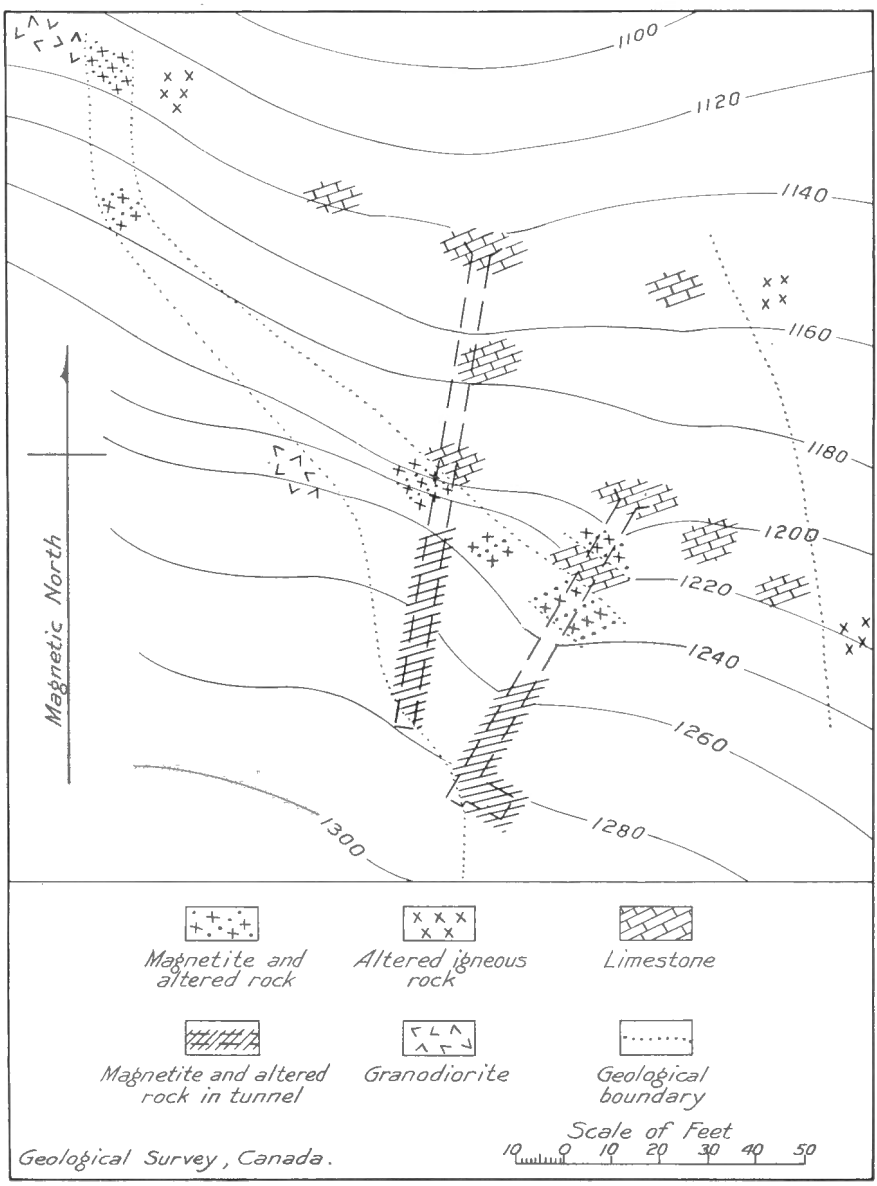

Figure 11. Magnetite deposit, Shoo Fly claim, Fanny bay, Phillips arm, Coast district, B.C.

outcrop was seen to extend downwards for at least a few feet on the inaccessible wall of the gully at whose edge the outcrop occurs.

Eastward from the Iron Duke claim, the upper slopes of the high ridge rising on the north side of Fanny bay are partly occupied by grey or white crystalline limestone and in connexion with this limestone one or more outcrops of magnetite are said to occur. These were not seen, but credible information was received that at least one of these occurrences was even less promising than the exposure on the Iron Duke claim. On the east shore of Phillips arm, opposite the mouth of Fanny bay, white limestone is developed and it is stated that in places on the lower slopes of the mountain outcrops of magnetite occur. On the ridge-like top of the mountain, at an elevation of about 3,800 feet, crystalline limestone forms the west end of the ridge; beyond, to the east, only diorite outcrops. Near the contact of the two rocks a natural sink-hole in the limestone shows on one side a mass of magnetite not over 4½ feet wide admixed with rock. Elsewhere in this pit and in a neighbouring pit are stringers and masses, a few inches wide, of magnetite.

MODE OF ORIGIN

The various deposits of magnetite seen occur at or close to the contact of granite or diorite with limestone or some bedded rock, and doubtless all are connected in origin with the granitic rocks and are replacement deposits formed after the period of plutonic invasion. In some cases they replace limestone or other types of bedded rock, in other cases they partly or wholly replace the diorite.

ECONOMIC CONSIDERATIONS

The magnetite occurrences seen on the Iron Duke claim, and those on the summit of the mountain on the east side of Phillips arm, are so limited in size as to appear to be of no economic importance except in so far as they indicate that at least some of the conditions favouring the formation of important bodies of magnetite were in existence.

On the Shoo Fly claim, the main tunnel penetrates a thickness of less than 40 feet of mineralized rock. At the surface, 60 feet vertically above the mineralized zone in the tunnel, mineralized rock outcrops, and presumably extends continuously for some considerable distance both to the southeast and northwest, but the limited exposures do not disclose any body of iron ore. In the second, higher tunnel, the amount of magnetite is very small. The zone of altered and partly mineralized rock presumably extends for a distance along or close to the limestone-diorite contact. Several outcrops of garnetite were seen a considerable distance southeast. Though the mineralized zone may have a considerable length, it is comparatively narrow. At the northwest end of the exposures, it is not more than 30 feet broad, at the southeast end it may be 60 feet broad at the surface, but a few feet vertically below the surface, in the higher tunnel, it is less than half this width. The amount of magnetite is variable, so that only limited portions are of the nature of iron ore. In the circumstances it does not seem probable that any single large body of iron ore is present. Even if the whole mineralized zone were magnetite ore, the tonnage present for each 100 feet in depth would amount only to about 75,000 tons.

(19) Menzies Bay, Seymour Narrows, Vancouver Island

Richardson[1] has stated that he was informed that iron ore (magnetite?) had been found on Vancouver island, 6 miles west of Menzies bay near Seymour narrows.

(20 a) Iron River, Vancouver Island

(*See* Figure 12)

LOCATION AND HISTORY

Iron river is a comparatively small stream which, flowing from the south, joins Quinsam river 4 miles nearly due south of the outlet of Lower Campbell river. The iron ore occurrences lie on the west side of Iron river about 1½ miles from its mouth. No well-defined trail leads to the occurrence which is usually reached from the Upper Campbell Lake highway by travelling south so as to strike Quinsam river above the junction of Iron river.

The property lies within the Esquimalt and Nanaimo Railway Land Grant. A number of years ago a tunnel 60 feet long was driven into a large exposure of magnetite and considerable stripping and some trenching were also done. The tunnel is now inaccessible. The following published accounts of the deposit have been noted.

Lindeman, E.: "Preliminary Report on the Iron Ore Deposits of Vancouver and Texada Islands"; Mines Branch, Dept. of Mines, Canada, Sum. Rept. 1907-08, pp. 39-40. A brief notice in which is given the size of the outcrops and the analyses of several samples.

Lindeman, E.: "Iron Ore Deposits of Vancouver and Texada Islands, British Columbia"; Mines Branch, Dept. of Mines, Canada, Pub. No. 47, 1909, pp. 20-21. Repeats information contained in above-mentioned report.

Lindeman, E., and Bolton, L. L.: "Iron Ore Occurrences in Canada"; vols. 1 and 2; Mines Branch, Dept. of Mines, Canada, vol. 2, pp. 15-16 (1917). A notice based on statements made in above publications.

Whittier, W. A.: "An Investigation of the Iron Ore Resources of the Northwest"; Univ. of Washington, Bureau of Industrial Research, Bull. No. 2, pp. 66-67 (1917). Compiled from previous publications.

GENERAL DESCRIPTION

Iron river at its junction with Quinsam river lies near the south end of an area of disturbed volcanic and sedimentary rocks, bounded, except to the north, by gently dipping Upper Cretaceous coal-bearing strata. The older group of beds is presumably Triassic. The sedimentary members are mainly argillites and occupy considerable areas.

The following account of the magnetite deposits is based on work by C. O. Swanson, field assistant.

On Iron river in the immediate vicinity of the magnetite deposits the strata are considerably altered. About 120 yards below the main ore occurrence, rusty weathering magnetite and rock-bearing magnetite are exposed in the bed of the stream. On the east side the breadth is 30 feet and the material is largely magnetite; on the west side the exposed breadth is less than 10 feet and the rock is less than one-half magnetite. The country rock is not visible, but is presumed to be siliceous argillite which outcrops nearby and is seamed with calcite. Upstream from the magnetite outcrop are exposures of siliceous argillite and altered, greenish

[1] Richardson, J.: "Report on Geological Explorations in British Columbia"; Geol. Surv., Canada, Rept. of Prog. 1873-74, p. 101.

igneous rocks cut by dykes of various kinds. Along zones of shearing, garnet, epidote, actinolite, and magnetite, in small amounts, have developed. Farther upstream, commencing about opposite the main magnetite exposures, beds of Cretaceous sandstone outcrop and continue to do so for a long distance beyond.

The main exposures of magnetite lie on the west slope of the stream valley. The lowest outcrops are 35 feet away from the stream and 50 feet above it; they extend up the hill-side to a height of 110 feet above the river and form a rectangular area 65 feet long by 35 feet broad. In the lower part of the outcrop, considerable sulphide is present, but the amount decreases upwards. A tunnel, now inaccessible, has been driven into the lower part of the outcrop. Lindeman[1] has stated that it is 60 feet long and

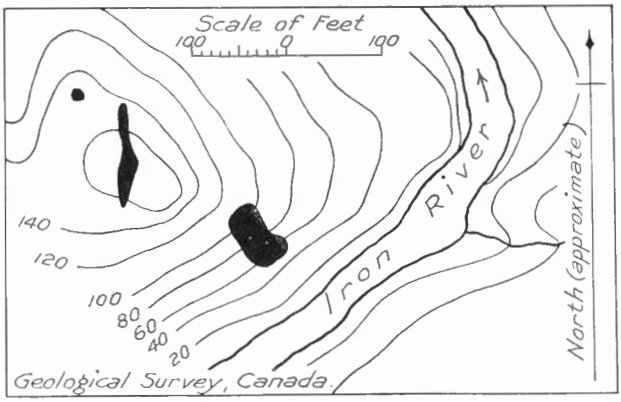

Figure 12. Magnetite deposit, Iron river, Vancouver island, B.C. Magnetite outcrops shown in solid black.

entirely in magnetite. In general the ore is largely finely granular magnetite with minute streaks and small, irregular patches that are coarsely crystalline. Chalcopyrite is comparatively abundant.

One hundred feet beyond and 60 feet above the upper edge of the main outcrop, there is, on the top of a knoll, an outcrop of magnetite nearly free from sulphide. Magnetite is exposed to the northward along a trench. In all, magnetite is exposed on the summit of the hill over an area averaging about 10 feet in width and having a length of 100 feet. A small outcrop of magnetite lies 50 feet west of the north end of the long outcrop. The nearest outcrops of bedrock lie nearly 100 feet away from the exposures of magnetite.

ECONOMIC CONSIDERATIONS

The main deposit or deposits presumably have originated by replacing country rock, but direct evidence regarding the mode of origin or the form of the deposit was not secured, for the exposures are practically limited to those of magnetite. If the larger exposure on the slope of the hill and the smaller, long outcrop on top of the knoll are parts of a single ore-body,

[1] Lindeman, E.: "Iron Ore Deposits of Vancouver and Texada Island, British Columbia"; Mines Branch, Dept. of Mines, Canada, 1909, pp. 20-21.

the deposit has a length of more than 250 feet and, in places, a breadth of 75 feet or more. The major dimensions might even be larger, but further trenching or other exploratory work are necessary before it can be established that one large ore mass is present and not several separate bodies each of comparatively small size. The tunnel driven in the lower outcrop only reaches to a point vertically below the edge of the surface outcrop. Since the tunnel is reported to be all in magnetite, it is reasonable to assume that the body extends some considerable distance below the floor of the tunnel. Assuming that the outcrops belong to one body 300 feet long, with an average breadth of 75 feet and extending 150 feet beneath the surface, the ore present would amount to 400,000 tons or more. On the summit of the knoll the drift covering is thin, possibly nowhere deeper than 6 feet, and it would be comparatively easy to determine there, the surface extent of the deposit. But on the slopes of this rise and on the top, west of the knoll, the drift covering may be thick, for no outcrops are visible in the general vicinity of the deposit.

(20 b) Iron Hill Claim, Upper Quinsam Lake

(*See* Figure 13)

LOCATION

Iron hill rises from the east shore of Upper Quinsam lake about 17 miles southwest of Campbell river on the east coast of Vancouver island. The locality is most conveniently reached by following the highway from Campbell river to Upper Campbell lake to where a trail leads south past Gooseneck lake to Little Quinsam lake, distant about 4 miles. From here it is 3 miles by water and a mile longer by trail to Granite creek, which enters Upper Quinsam lake about midway along its southeast side. Iron hill is situated a short distance back from the lake and on the west side of the valley of Granite creek. The main ore occurrences are on the northeast end of the top of the ridge whose summit rises 630 feet above Quinsam lake or 1,820 feet above sea-level.

HISTORY

The Iron Hill deposit lies within the limits of the Esquimalt and Nanaimo Railway Land Grant and was acquired under lease by ex-Senator Jones, of Seattle, and associates, who prior to 1914 drove several tunnels and made a few open-cuts on the property. Later accounts refer to the property as being in the hands of the Quinsam Lake Iron Syndicate. No work has been done on the property in recent years. Two tunnels are now inaccessible, but one 130 feet long is still open to inspection.

Previous accounts of the deposit are, so far as known, limited to the following articles.

Anon: "Campbell River Iron Deposits"; Min. Eng. and Elect. Rec., vol. 19, No. 3, p. 75 (1913).

Brewer, W. H.: "Report on the Occurrences of Iron-ore Deposits on Vancouver and Texada Islands, B.C."; Ann. Rept., Minister of Mines, B.C., 1916, p. 296.

Stansfield, A.: "The Commercial Feasibility of the Electric Smelting of Iron Ores in British Columbia"; Dept. of Mines, B.C., Bull. No. 2, p. 32 (1919). Contains notes furnished by the B. L. Thane Company, of San Francisco, in which it is stated that the deposit probably contains 500,000 tons of magnetite.

GENERAL GEOLOGY

Upper Quinsam lake lies in an area of disturbed and variously altered sediments and volcanics penetrated by large and small masses of granitic rocks. The sediments and volcanics, so far as known, are mainly perhaps almost entirely of Triassic age. The plutonics are of late Jurassic or, possibly, early Cretaceous age. All are older than the coal-bearing Upper Cretaceous sediments of the east coast of Vancouver island. The pre-plutonic rocks are largely of volcanic rocks both intrusive and extrusive, but with them occur clastic and limestone strata which in places have a very considerable thickness and are developed over considerable areas.

In the neighbourhood of Upper Quinsam lake and for some distance northwards granodiorite and granite are the prevailing rocks. In the vicinity of Iron hill, granodiorite outcrops on the lower slopes of the ridge, which is nearly 1 mile long. The summit of the ridge is mainly occupied by dark volcanic rocks which vary in grain from very fine to medium and in places are porphyritic, amygdaloidal, or agglomeratic. They are presumably a series of lavas and intrusive bodies. Their general attitude was not determined. Dark, basic dykes cut them and occasional pale-coloured dykes from the granodiorite mass are also present. At the northeast end of the flat top of the ridge, pale grey, nearly white, very pure crystalline limestone outcrops over an area 1,100 feet long by 400 feet wide. The limestone in places is faintly banded white and grey, but no distinct evidence of bedding was noted. It overlies the finely granular, basic, volcanic rocks and the course followed by its lower boundary, considered with reference to the topography, indicates that the mass of limestone, though affected by minor undulations, dips northeasterly at angles of 10 to 20 degrees or less. The patch of limestone is presumably a remnant of a very considerable bed and has been preserved as a result of the development of a body of magnetite-bearing garnetite along the contact between the limestone and the underlying volcanic rocks. The resistant magnetite-garnetite outcrops as a border to the limestone mass.

DESCRIPTION OF THE ORE OCCURRENCES

The main occurrence is a series of outcrops of magnetite and garnetite in varying proportions, which form a nearly completely exposed annular zone enclosing the area of crystalline limestone and surrounded by the dark, fine-grained volcanic rocks. The limestone and the encircling zone of magnetite and garnetite form an elliptical area whose major axis trends nearly due east and has a length of 1,300 feet, and whose minor axis measures 600 feet. The elliptical area contains about 12 acres, of which somewhat more than one-half is underlain by magnetite and garnetite. The area of limestone and ore lies at the north end of a narrow, comparatively flat-topped ridge which trends southwesterly. The outcrops are mainly on the summit, but are in part on the upper north slope. The limestone, the magnetite-garnetite, and the surrounding volcanic rocks are well exposed over the summit of the ridge, but are poorly exposed on the north slope where large areas are wholly drift covered. The inner boundary of the magnetite-garnetite, against the limestone, is well defined, but the outer limit is drift covered except along the south margin. On any part of the annular zone of magnetite-garnetite, the immediately adjacent outcrops of limestone are above, and the volcanic rocks are

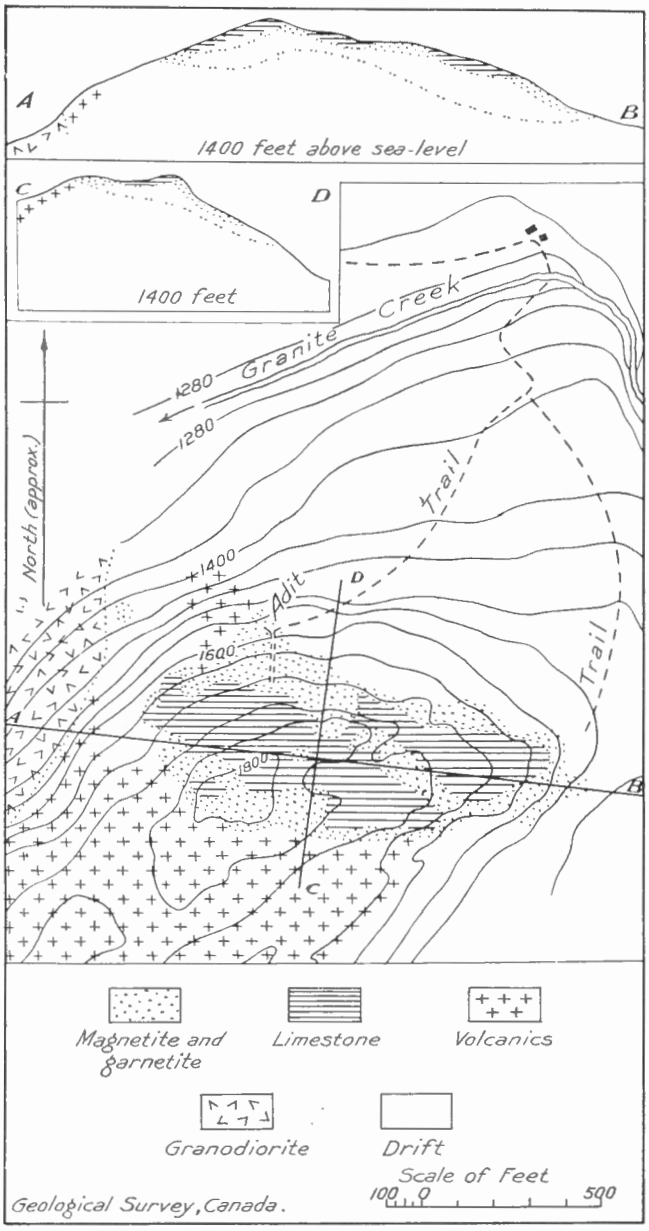

Figure 13. Magnetite deposit, Iron hill, Quinsam lake, Vancouver island, B.C.

below, the magnetite-garnetite exposures which have every appearance of belonging to a sheet-like body interposed between a floor of volcanic rocks and a partly removed cover of limestone. The lower boundary of the magnetite-garnetite against the underlying volcanics appears to be a comparatively even, though warped, plane, but the upper boundary against limestone is irregular, so that the thickness of the outcropping parts of the magnetite-garnetite mass varies from place to place.

At the east end of the occurrence the magnetite-garnetite mass is well exposed in a steeply rising face. Over an area measuring 200 feet east and west and varying from 100 to 200 feet in breadth in a north-south direction, exposures are nearly continuous and there is a difference of elevation of more than 80 feet between the highest and lowest outcrops. The material is very largely granular-crystalline magnetite with only a slight admixture of garnetite. The upper boundary against the limestone, though not exposed, appears to be sharply defined. The lower boundary is against drift, but it is imagined that the contact with the floor of volcanic rocks does not lie more than a few feet below the lowest exposures of magnetite.

To the west, along the south border of the occurrence, the outcrop of magnetite-garnetite narrows and in a distance of about 600 feet the total thickness dwindles to about 10 feet or less and both the upper and lower boundaries are closely defined by outcrops of the limestone and volcanics. Still farther westward along the south edge, the thickness of the magnetite-garnetite body remains small, but is inferred to increase rather rapidly in a north direction to 20 feet and over. Over much of the south outcrop, the exposures are of garnetite and magnetite admixed in widely varying proportions.

Along the north face to near the west end of the body, the magnetite-garnetite is widely exposed over a considerable height on the steep hillside, so that the mass has the appearance of varying in thickness between 40 and 100 feet. The magnetite-garnetite in one stretch of 300 feet is exposed over a width of 100 feet or more. The difference in elevation between the outer, lower edge and upper, inner edge, is more than 100 feet. At the west end the body appears to be comparatively thin. The material is not uniform and in places is largely garnetite. Towards the northwest corner, a tunnel 130 feet long has been driven into the body. Along the tunnel the following succession is observable, the distance being measured from the tunnel mouth:

0— 28 feet, mainly magnetite
28— 57 feet, mainly garnetite
57— 70 feet, mainly magnetite
70—100 feet, garnetite with some magnetite
100—130 feet, mainly magnetite

A tongue-like area of garnetite and magnetite projects easterly into the central limestone area, from the southeast edge of the annular outcropping area of magnetite and garnetite. This projection is 400 feet long and averages 60 feet in width. The outcrops are largely of garnetite, save towards the east end where magnetite is prominent. An isolated outcrop of garnetite and magnetite occurs 150 feet east of the east end of this tongue.

Four hundred feet west of the mouth of the main tunnel is an outcrop of magnetite about 50 feet long and half as wide. A short distance east are exposures of granodiorite. The magnetite appears to be in volcanic

rocks at or close to the granodiorite contact. This body of magnetite seems to be quite separate from the main occurrence, which lies to the east and 100 or more feet above it.

At the southwest end of the ridge, 3,500 feet away from the main tunnel and across an intervening area of greenstones, are other exposures of magnetite. These for the most part occur in a stretch of 300 feet ending at the side of a small stream. Five groups of outcrops are visible. Each is small and consists of a few inches or several feet of comparatively pure, fine-grained magnetite with bordering zones of greenstone impregnated with magnetite. A short distance downstream, a body of magnetite a few feet wide is visible for a short distance.

MODE OF ORIGIN

The main ore occurrence at the northeast end of the ridge presents many of the essential characters of the type of deposit known as contact-metamorphic which is exemplified by the magnetite deposits of Texada island and elsewhere. In this case the replacement has taken place along the contact of a body of limestone with underlying, fine-grained, igneous rocks presumably belonging to a volcanic series. The plane of contact in spite of irregularities has a general low dip. The magnetite-garnetite zone seems to be sharply defined, both against the underlying igneous rocks and the overlying limestone. Any gradation that exists must be confined to thicknesses of not more than 5 feet. In a few places exposures are sufficient to indicate that in these places there is no gradation at all. The magnetite-garnetite mass appears to replace only the limestone, but there is no available direct evidence indicating that replacement of the igneous rocks has not also taken place. The lower boundary of the magnetite-garnetite body seems to be a gently warped plane. The upper boundary, against limestone, seems less regular. For instance, the long projection into the limestone from the southeast seems to indicate a marked rise in the "roof" of the ore zone. The magnetite-garnetite body presumably was produced by agents accompanying the granodiorite of the lower western slopes of the ridge, though the two rocks are not now in contact. The body of magnetite lying west of the tunnel entrance, and the occurrences of magnetite at the southwest end of the ridge, both lie in the volcanic rocks at or close to the edge of a mass of granodiorite. These deposits also appear to be replacement bodies, but replacing volcanic rocks and not limestone.

ECONOMIC CONSIDERATIONS

The group of small outcrops of magnetite and magnetite-impregnated rock at the southwest end of Iron hill do not appear to indicate the presence of a deposit, or deposits, of magnetite of economic value. The limited exposures at the best show only 2 or 3 feet of ore, the rest is low grade. The area partly impregnated with magnetite is closely limited on the south and east by exposures of barren greenstone. In the opposite directions it may be that more important deposits exist, but if so they are drift-covered.

The 50-foot long outcrop of magnetite situated 400 feet west of the main tunnel may belong to an important body of ore, but the present

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limited exposures do not seem to give any indication of what the size of the body may be. It is not unlikely that it is quite small and that it is only one of the many small masses known to have developed in analogous positions in other parts of the general region.

The large, annular outcrop of intermixed magnetite and garnetite which occurs on the east end of the summit of Iron hill seems to be the outcropping edge of a large body. All available evidence indicates that the magnetite-garnetite mass is bed-like in form and that it everywhere underlies the limestone lying within the annular area of magnetite and garnetite. The positions of the outcrops of the volcanic rocks, of the magnetite-garnetite, of the limestone, and, where determinable, of the upper and lower boundary of the magnetite-garnetite mass, relative to one another and to the topographical features when interpreted by vertical profiles of the locality, lead to the inference that the bottom of the magnetite-garnetite body is a gently warped plane with a general dip towards the northeast of 10 degrees to 20 degrees (*See* cross-section on Figure 13). Assuming that the ore-bearing body has the form indicated, it underlies an elliptical area of about 12 acres with a major axis of 1,300 feet and a minor axis of 600 feet. It is known that the body is comparatively thin along its southern margin; in several places it was observed to be less than 10 feet. Along most of the northern margin it has every appearance of being much thicker; at the east end it is apparently 100 feet thick, but westward the thickness seems to diminish and it is calculated to be about 60 feet at a point at the limestone contact above the face of the main tunnel. Using all available data, it is estimated that the volume of the magnetite-garnetite body is 1,000,000 cubic yards, of which by far the greater amount lies beneath the limestone cover which it is estimated is nowhere thicker than 50 or 60 feet. The whole content of the magnetite-garnetite body is not ore, nor do the natural exposures permit of forming a reliable estimate of the proportion which might be classed as ore. At the east end where the body is apparently thickest, there are large exposures of comparatively pure magnetite, and it is perhaps warranted to conclude that one-half of the volume of the body consists of iron ore in reasonably homogeneous masses large enough to be considered ore-bodies. On such a basis the ore content is estimated to be 1,700,000 tons of iron ore. This estimate of the ore content should be regarded as provisional only, for neither the outlines of the body nor the mode of distribution, size, or average iron content of the ore masses within it have been determined with certainty. These factors could readily be ascertained by a series of vertical diamond-drill holes.

(21) Bacon Lake

Bacon lake is a small body of water which drains into Upper Campbell lake on the northwest side about $1\frac{1}{2}$ miles from the foot of the lake. A highway leads from Campbell River to the southeast shore of Campbell lake. No well-defined trail leads to Bacon lake which is separated from Campbell lake by a comparatively low ridge less than 1 mile broad. The only known published reference to deposits of magnetite in this vicinity is the following.

Anon.: "Campbell River Iron Deposits"; Min., Eng., and Elect. Rec., vol. 19, No. 3, p. 75 (1913). Magnetite outcrops are stated to be traceable over a length of 2 miles and a width of 2,000 feet.

The district is occupied by associated sedimentary and volcanic rocks, presumably Triassic, penetrated by large bodies of granodiorite and diorite of late Jurassic or early Cretaceous age. On the ridge separating Upper Campbell and Bacon lakes magnetite is known to occur in several localities, more particularly in the vicinity of a tunnel which has been driven on the slope rising from the northwest shore of Upper Campbell lake a mile from its outlet and also in the vicinity of Bacon lake. Very little work has been done on any of the magnetite outcrops and none of any great size was seen. What appears to be the most important occurrence lies about 300 feet east of the outlet of Bacon lake. At this point, in a length of 300 feet, magnetite is visible in ten or twelve isolated outcrops which lie within a zone 10 to 25 feet wide and are bordered in part by altered volcanics, in part by crystalline limestone, and in part by diorite. The individual outcrops range from several feet to 40 feet in length, but are all less than 5 feet wide. At most exposures the magnetite is nearly pure, but at some is disseminated through greenstone. Rock outcrops are rare and no work has been done on the deposit. At one outcrop the magnetite appears to lie nearly horizontally upon greenstone. It may be that the magnetite outcrops belong to one or more, nearly horizontal, tabular bodies 10 to 15 feet thick, extending into the hill and overlain and underlain by greenstone and limestone. The possible amount of ore that may be present cannot be safely estimated until some trenching and stripping have been done. If the magnetite occurs in two nearly horizontal, tabular masses it seems highly improbable that more than 50,000 tons of ore are present, and it might be that no more than 10,000 tons are present.

(22) West Redonda Island

(*See* Figures 14 and 15)

LOCATION

West Redonda island lies 100 miles northwest of Vancouver or 30 miles north of Texada island. It is a member of the large group of islands lying between Vancouver island and the mainland at the northwest end of the strait of Georgia. West Redonda faces the mainland, from which it is separated by Pryce channel, running east and west. The iron ore occurrences are on the north side of the island a short distance from the shore of Pryce channel.

The north side of the island is bold, with steep, in part precipitous, slopes rising in several peaks and ridges about 3,000 feet high. The mineralized outcrops (*See* Figure 15) are three in number, lie close to the shore, and may be reached by nearly obliterated trails. The trail leading to the most northerly occurrence, the Elsie claim, leaves the shore close to the mouth of a small stream bearing south 65 degrees west from Elizabeth island on the north side of Pryce channel. A group of mining claim location posts marks the commencement of the trail which leads straight up the slope to the ore outcrop 200 yards from the shore and 400 feet above it.

The trails to the two other showings leave the shore close to the mouth of Eagle creek about one-half mile southeast of the commencement of the trail to the Elsie body and about the same distance west from a prominent quarry face in white crystalline limestone. One trail runs

westerly to an ore outcrop on the boundary between the Eagle and Black Warrior locations on Pine creek at an elevation of about 300 feet and distant about 400 yards from the shore. The second trail runs southerly to the valley of a second stream and follows up it a short distance to where at an elevation of 1,000 feet and 530 yards from the shore, mineralized rock outcrops on the Homestake mining location.

HISTORY

The Elsie claim was located in 1892 and Crown-granted in 1895. In 1920 it was part of the estate of John Hendry of Vancouver. Judging from the number of location posts standing on the property it would appear as if at some time title to the property had been disputed. In 1893 the ore outcrop was cleared and 626 tons of ore was quarried and shipped to the Oswego Iron and Steel Company, Oregon. Since then one or more lots of a few tons of ore have been shipped.

The two remaining mineralized outcrops occur on claims known as the Black Warrior group, which were reported to be, in 1920, the property of the Redonda Iron Copper Company. The group of claims extends from the shore inland along the west side of the Elsie claim, around it, and back to and along the shore on the east side. The claims on which mineralized rock outcrops have been surveyed and, presumably, Crown-granted. On Pine creek, a tunnel has been driven for about 12 feet and a little stripping performed. At the occurrence to the south, on the Homestake claim, a small amount of stripping has been done.

The following list contains the titles of such published statements as have been noted and that make more than a passing reference to these ore occurrences.

Ann. Rept., Minister of Mines, B.C., 1893, p. 1,036. Contains generalized statements relating to the Elsie claim.

Kimball, J. P.: "Secondary Occurrences of Magnetite on Islands of British Columbia by Replacement of Limestone and by Weathering of Eruptives"; Am. Geol., vol. 20, pp. 13-27 (1897). Describes the Elsie ore-body and offers an explanation of its mode of origin.

Ann. Rept., Minister of Mines, B.C., 1901, pp. 113-114. Contains generalized statements relating to the Elsie claim.

Bancroft, J. A.: "Geology of the Coast and Islands between the Strait of Georgia and Queen Charlotte Sound, B.C."; Geol. Surv., Canada, Mem. 23, pp. 131-133 (1913). Contains a description of the Elsie ore-body and an explanation of its mode of origin. See also:

Geol. Surv., Canada, Sum. Rept. 1907, pp. 17-18.

Lindeman, E., and Bolton, L. L.: "Iron Ore Occurrences in Canada"; Mines Branch, Dept. of Mines, Canada, vol. 2, p. 17 (1917). Contains a condensed description of the Elsie ore-body as compiled from published accounts.

Whittier, W. H.: "An Investigation of the Iron Ore Resources of the Northwest"; Univ. of Washington, Bureau of Industrial Research; Bull. No. 2, p. 73 (1917). Contains a condensed description of the Elsie ore-body as compiled from published accounts.

Stansfield, A.: "The Commercial Feasibility of the Electric Smelting of Iron Ores in British Columbia"; Dept. of Mines, B.C., Bull. No. 2, p. 34 (1919). Contains a summary description of the Elsie ore-body derived from an engineer's private report.

Brewer, W. M.: "Western District (No. 6)"; Ann. Rept., Minister of Mines, B.C., 1918, pp. 282-283. Contains descriptions of the ore occurrences on the Elsie claim and the Black Warrior group.

Brewer, W. M.: "Western District (No. 6)"; Ann. Rept., Minister of Mines, B.C., 1919, pp. 215-217. Contains description of the ore occurrences on the Elsie claim and the Black Warrior group.

GENERAL GEOLOGY

West Redonda island lies within the area of the composite batholith of the Coast range. This batholith is presumably of late Jurassic age and according to Bancroft[1] includes rocks ranging in composition from granites

[1] Bancroft, J. A.: Op. cit., pp. 82-111.

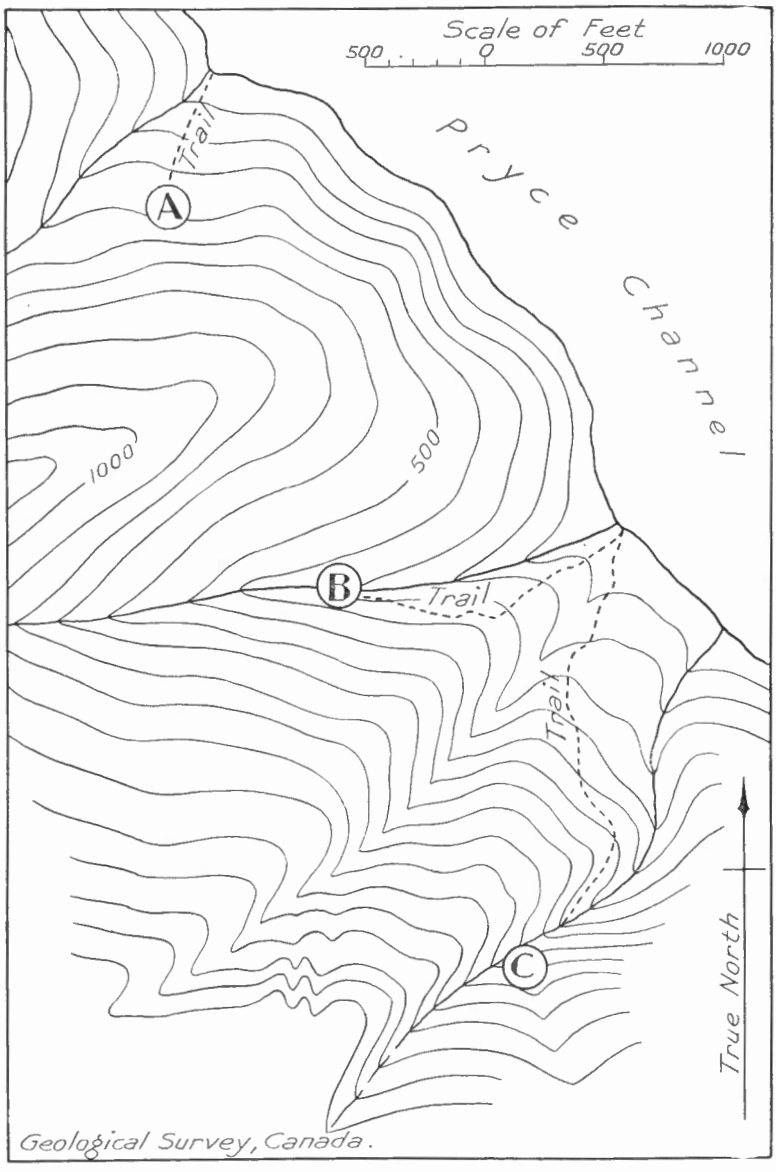

Figure 14. Magnetite deposits, West Redonda island, Coast district, B.C. Localities referred to in text are indicated, respectively, by letters A, B, and C. Contours approximate, interval 100 feet.

to hornblendites and holds large and small remnants of the sedimentary and volcanic strata that once overlay the plutonic rocks. The various rock types in places gradually pass into one another, whereas in other places different varieties cut one another. The included bodies of sediments and volcanics vary greatly in size, ranging from areas of many square miles down to such as are measurable in feet. These older rocks also vary in character from such as seem but little disturbed and comparatively unaltered, to others which show all gradations from clearly recognizable sediments or volcanics, to vague areas of rock so altered both physically and chemically as to appear as local phases of the plutonic rocks.

In the vicinity of the mineral claims on West Redonda, the plutonic rocks range in character from hornblende granite to diorite of medium grain and seemingly grade into fine-grained, darker types. With these rocks are associated many isolated masses of limestone, in places altered to garnetite, and of fine-grained, dark rocks possibly representing recrystallized volcanic rocks. These bodies of sediments and volcanics seem to occur partly in narrow bands, some of which are many yards in length, and partly as detached blocks and masses characterizing narrow, band-like areas. In addition, dyke rocks of various types are present. A short distance east of the mineral claims, a wide band of white crystalline limestone is exposed at the shore and is reported to extend far up the mountain slope. The complex of rocks visible in the vicinity of the mining claims seems to mark a zone of disrupted and partly assimilated sediments and volcanics once part of a large body of bedded strata which included the wide limestone band, but from which they are now separated by the intrusive granitic rocks.

DESCRIPTION OF THE ORE OCCURRENCES

Outcrops of magnetite were seen at three localities whose relative positions are indicated on Figure 14. They lie on a nearly straight line following a southeasterly direction. The most northerly occurrence (locality "A" Figure 14), is on the Elsie mineral claim and is situated at an elevation of 400 feet and is distant 200 yards from the seashore. At this place a magnetite body between 50 and 55 feet long and having a maximum breadth of 20 feet has been stripped and partly quarried. The outcrop has the outline of an elongated oval whose major axis strikes southeastward. The mass lies on a steep hill-side and shows in a broken face 20 to 30 feet high. The northeast edge, on the downhill side, is concealed beneath the refuse-covered floor of the quarry, but presumably no considerable part of the mass would have been deliberately buried beneath waste rock and, therefore, it is assumed that practically the whole ore mass is still exposed.

At the northwest end of the outcrop the magnetite is sharply separated by a nearly vertical plane from what is presumed to be a porphyritic phase of the widespread dioritic rocks, and this same porphyritic rock extends for a few feet southeastward along the southwest boundary to where it ends against brownish and pinkish garnetite. The contact between the porphyry and garnetite runs up hill away from the ore-body. The garnetite forms the southwest boundary for a few feet, but beyond this the rock bounding the ore is a dense, compact, greenish rock holding seams of magnetite and small splotches of garnet. Dense, greenish rocks border

the magnetite to near its southeast end, where a porphyritic rock outcrops which seems to grade into normal diorite. At the southeast end and for a few feet away down hill are exposures of dark, dense, greenish rocks and garnetite. The northeast edge is concealed by waste rock from the quarry in the ore.

Along the slope of the hill and uphill, the rocks exposed are mainly diorite. Apparently the ore-body occurs partly within a narrow band, only a few yards wide, of much altered limestone (now garnetite) and perhaps other sediments and volcanics, enclosed in diorite which grades into a porphyritic rock at its contact with the sediments. The ore mass seems to extend diagonally across the width of the sedimentary band, so that at both ends it is in contact with diorite.

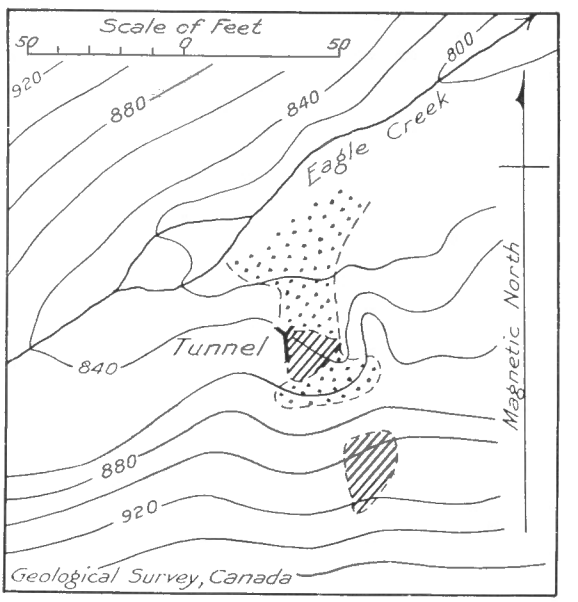

Figure 15. Magnetite deposit, Black Warrior and Eagle claims, West Redonda island, Coast district, B.C. Magnetite shown by ruling; talus, etc., by stipple.

The magnetite varies from finely granular, almost dense, to rather coarse, with individual grains measuring one-sixteenth of an inch and more in diameter. Near the walls of the ore-body, the magnetite is much admixed with various silicates, but the boundary between ore and country rock is very sharp. Towards the centre of the magnetite mass the silicates markedly decrease in amount. No sulphides were observed.

Uphill from the southern termination of the main ore-body and distant about 50 feet, is a body of magnetite seemingly not less than 20 feet long and at the widest part not less than 10 feet broad. This magnetite body is almost entirely concealed beneath moss and vegetation and possibly has never been cleaned off. It is apparently surrounded by the porphyritic phase of the diorite. This occurrence may constitute the second ore-body referred to in some of the earlier descriptions of the locality.

Magnetite ore occurs at a second locality (locality "B", Figure 14) 660 yards south of the Elsie body. The outcrops lie in the south wall of Eagle Creek valley at an elevation of about 330 feet and 400 yards inland from the mouth of the creek. The ore exposures occur close to the boundary of the Black Warrior and Eagle claims and probably extend into both claims. The rocks exposed are mainly diorite and finer grained rocks possibly representing inclusions of much altered sediments and volcanics. A few feet above the creek bed, on the south side, a tunnel has been driven for a length of 12 feet along the west edge of a body of magnetite which has a breadth of about 18 feet (*See* Figure 15). Talus covers the northern extension of the body, but the deepest certainly does not reach as far as the stream bed 50 feet away. The mass continues up the steep hill-side for about 20 feet to a drift-covered patch a few feet wide and on whose uphill side the dioritic rock is altered and sparingly mineralized with pyrite and magnetite. A second isolated mass of magnetite outcrops to the south over an area about 25 feet long and with a maximum breadth of 17 feet. This second outcrop is separated from the first by a barren, unmineralized interval of dioritic rock about 20 feet wide. The lower body of magnetite is sharply defined against the country rock. It is largely composed of magnetite, partly dense, partly coarsely crystalline. Large blades of tremolite are common and in places pyrite is sparingly present and various silicates are prominent. The second mass of magnetite displays the same general characters.

The third magnetite deposit (locality C, Figure 14) is 620 yards south of the second. At this place at an elevation of about 1,000 feet and at the end of the trail in the bed of the main stream, a tributary stream enters on the east side. This stream, dry in the summer, falls precipitously over rock ledges. Upwards along the stream channel for a length of 300 feet, white crystalline limestone occurs on the north edge; the rest of the bare rock floor and the wooded slopes of the south side are of granitic rocks varying in character, but mainly diorite. A dyke of porphyritic rock cuts across the gully, dividing the limestone on the north side into two bodies. Upwards the stream channel bends first south and then east to where for several hundred feet it flows over granitic rock in a body about 50 feet wide flanked on either side by limestone. The granitic rocks of the upper stretch of the stream are somewhat altered, carry epidote, etc., and a very little sparsely disseminated magnetite. The granitic rocks on the south side of the lower part of the stream at a distance of 20 to 40 feet south of the limestone contact are much altered in a zone 250 feet long and having a maximum breadth of 50 feet. This zone over the greater part of its length forms a steep rise on the south side of the tributary gully; it appears to end upstream. Down stream it probably is continuous with a mineralized zone occurring on and along the west side of the main stream. The mineralized zone in large part is plainly composed of altered granitic rocks now characterized by the presence of much epidote, some garnet, magnetite, pyrite, etc. In places magnetite forms small patches thickly disseminated through widths of 1 to 5 feet.

MODE OF ORIGIN

The three magnetite occurrences are alike in that the iron oxide and associated minerals seem to occur replacing country rock and all three occurrences are doubtless due to the action of emanations associated in origin with the invading plutonic rocks.

The two more southerly occurrences, namely the one on Eagle creek and the one on the Homestake claim, are not promising. The magnetite is much admixed with silicates or patches of unreplaced rock and the ore-bodies or mineralized zones are of comparatively small dimensions. The conditions are such that it seems probable that all ore masses will be of relatively small sizes, of irregular shapes, and so sporadically developed as to make profitable mining an impossibility.

The main ore-body on the Elsie claim has an outcropping area of about 800 square feet. Assuming it to be all merchantable ore (which it is not) and that for a considerable depth it maintained the same cross-section, the ore-body would be capable of producing about 1,000 tons of ore for every 10 feet in depth. But the ore-body is definitely related to a comparatively narrow mass of limestone surrounded by dioritic rocks and although it is possible this limestone band may extend downward for many hundreds of feet and even increase in size, yet the chances are that it will decrease in size and end at a comparatively shallow depth. That is, the probabilities are that the Elsie main ore-body will decrease in cross-section and terminate before reaching any great depth. It is probable, therefore, that the body contains only a few thousand tons of ore. There is no certainty that the ore mass extends vertically downwards, it may pitch in one direction or another, may irregularly contract and expand, or the mineralization may take the form of sporadically developed bodies within the limestone mass.

Besides these three ore occurrences, magnetite bodies are said to have been discovered on the opposite mainland on the north side of Pryce channel. No definite information could be obtained regarding these supposed discoveries. Float magnetite was observed along the bed of a stream emptying into the sea $2\frac{1}{2}$ miles west of Elizabeth island. Along this stream the usual dioritic rocks were seen, with inclusions and bands of white, crystalline limestone and other rocks.

(23) Sable River, Vancouver Island

Source of Information. Richardson, J.: "Report on the Coal Fields of Vancouver and Queen Charlotte Islands"; Geol. Surv., Canada, Rept. of Prog. 1872-73, pp. 92-93.

Richardson states that on Sable river, $2\frac{3}{4}$ miles from its mouth at Fanny bay on the east coast of Vancouver island, the Cretaceous strata 28 feet above their base hold 2 to 3 feet of black shale . . . . "with nodules of iron ore . . . . varying in length from 6 inches to 4 and 5 feet, and in thickness from 6 to 18 inches, while others are round, with a diameter of 18 inches." . . . One sample was found to contain 36·8 per cent iron and another, 29·8 per cent; both samples contained much carbonate and large quantities of insoluble matter.

It is not likely that this deposit will ever be a source of iron ore. The associated Cretaceous strata occur nearly continuously along the east coast of Vancouver island for a length of 135 miles from Campbell river southeastward, but, apparently, the nodular, iron-containing strata are nowhere any better developed than on Sable river.

(24) Texada Island; Puget Sound Iron Company's Property

(*See* Figures 16 to 18)

LOCATION

Texada island has a length of 30 miles, lies in the strait of Georgia about 50 miles northwest of Vancouver, and is distant 2 to 4 miles from the mainland. The most important iron ore deposits occur on the west coast in the north part of the island, may be reached by road from either Vananda or Blubber bay, lie 4 miles directly south of Vananda, and are the property of the Puget Sound Iron Company of San Francisco.

HISTORY

The property of the Puget Sound Iron Company consists of 3,094 acres on the southwest coast of the island and extends for 3½ miles northwestward from Gillies bay. The property, or a major part of it, was acquired in 1875 within a few years of its discovery and between 1883 and 1893 considerable development work was done on the Prescott ore-body, the farthest northwest of the larger magnetite masses. In 1885 operations were practically suspended, but work was resumed in the autumn of 1886 and during the winter ore was mined and shipped to Irondale, Washington, U.S.A. Mining operations continued for several years, but by 1890 shipments ceased and work was discontinued. By this time one of the ore masses at the Prescott mine had been almost completely removed. Sometime before 1897 the company determined to prospect where copper ore was showing and commenced the sinking of a shaft located several hundred feet below and in front of the main exposures of iron ore. By 1899 the shaft had reached a depth of 150 feet and at the bottom a drift had been run northerly for a distance of several hundred feet to a point approximately under the main iron ore outcrops and had entered a body of magnetite. For several years development work was continued at the surface on iron ore-bodies of the Prescott mine and small ore shipments were made. In 1901 the Prescott mine was leased to the Pacific Steel Company and during the next few years ore was shipped to Irondale. By 1902 a large quarry had been opened in ore. Prior to this date, several open-cuts had been made in the face of the Paxton ore-body.

No ore shipments were made in 1904, but a long cut was driven into a large showing on the Prescott. The mines were again leased and in 1907 and 1908 active preparations were under way for mining and shipping both copper and iron ore. By this time the 150-foot shaft on the Prescott mine had been connected with the surface by a tunnel nearly 400 feet long which opened lower down the hill-side nearer the seashore. It is stated that at about this time, 1,000 tons of ore was shipped from the Lake ore-body, the easternmost of the three principal iron ore outcrops. Mining operations seem to have ceased for a while in 1908 or 1909. During 1916, bunkers and a tramway were constructed on the Prescott property for handling ore from the copper prospect near the shaft, and about this time a second tunnel was driven into the hill from a point near, but below and to one side of, the collar of the shaft. So far as known, little or no copper ore was produced. Since then no work has been performed on the properties and in 1922 a fire destroyed practically all the buildings.

The following table gives the shipments of ore for various years as stated in different publications. Save for a few hundred tons shipped as a flux to the Vananda smelter, all the ore was delivered to the blast furnace at Irondale, Wash., U.S.A. No records are available of shipments made earlier than 1885. If any were made, their total amount probably would not exceed 15,000 tons.

Year	Tons
1885	213
1886	4,414
1887	1,579
1888	8,176
1889	2,100
1900	336
1901	2,500
1902	6,290
1903	2,290
1908	1,000
	28,898

The following is a list of all the more important publications noted that relate to these ore deposits.

Richardson, J.: "Report on Geological Explorations in British Columbia"; Geol. Surv., Canada, Rept. of Prog. 1873-74, pp. 99-100. The recently discovered iron ore deposits on Texada island are described as being bedded deposits.

Ann. Rept., Minister of Mines, B.C., 1874, p. 35; 1875, p. 25; 1876, p. 429; 1897, p. 565; 1891, pp. 805-806; 1900, p. 925; 1901, pp. 1,102 and 1,111-1,112; 1903, p. 205; 1904, p. 247; 1907, p. 152. Brief notices for the most part indicating progress made in mining and development.

Dawson, G. M.: "Report on a Geological Examination of the North Part of Vancouver Island and Adjacent Coasts"; Geol. Surv., Canada, Ann. Rept., vol. II, pt. B, pp. 31-39 (1887). The iron ore deposits are described and they are stated to be . . . . "contact deposits . . . . at or near the junction of the granitic mass with the stratified rocks . . . . The appearances indicate that the formation of the deposit occurred contemporaneously with the intrusion of the granitic mass."

Dawson, G. M.: "The Mineral Wealth of British Columbia, etc."; Geol. Surv., Canada, vol. IV, pp. 99-100 (1891).

Kimball, J. P.: "Secondary Occurrences of Magnetite, etc., etc."; Am. Geol., vol. 20, No. 1, pp. 13-27 (1897). The iron ore deposits are described and stated to be replacement bodies formed by solutions which derived their iron content from the weathering of basic igneous rocks.

Carmichael, H.: "The Iron Ores of the Coast of British Columbia"; Ann. Rept., Minister of Mines, B.C., 1902, pp. 201-229. A description of the principal iron ore deposits.

Leith, C. K.: "Iron Ores of the Western United States and British Columbia"; U.S. Geol. Surv., Bull. 285, p. 196 (1906). The iron ores of Texada island are stated to be replacements of limestone and to be probably of igneous origin.

LeRoy, O. E.: "Preliminary Report on a Portion of the Main Coast of British Columbia and Adjacent Islands, etc., etc."; Geol. Surv., Canada, 1908, pp. 40-44. The deposits are described. Kimball's explanation of their mode of origin is adopted.

Leith, C. K.: "The Iron Ores of Canada"; Jour. Can. Min. Inst., vol. 11, pp. 91-101 (1908). The Texada deposits are cited as examples of the pegmatite type of iron ores.

LeRoy, O. E.: (in) "Report on the Mining and Metallurgical Industries of Canada, 1907-8"; Mines Branch, Dept. of Mines, Canada, 1908, pp. 140-141. *See also* Sum. Rept. 1906, p. 33.

Lindeman, E.: "Iron Ore Deposits of Vancouver and Texada Islands, British Columbia"; Mines Branch, Dept. of Mines, Canada, 1909, pp. 21-23.

Anon.: "Texada Island Iron Deposits"; B.C. Min. and Eng. Rec., vol. 16, pp. 102-103 (1910).

McConnell, R. G.: "Texada Island, B.C."; Geol. Surv., Canada, Mem. 58, pp. 74-90 (1914). A detailed description of the iron ore occurences. The deposits are described as being contact metamorphic deposits.

See also Geol. Surv., Canada, Sum. Rept. 1908, pp. 49-50.

Lindeman, E., and Bolton, L. L.: "Iron Ore Occurrences in Canada"; Mines Branch, Dept. of Mines, Canada, vol. 1, pp. 25-30 (1917).

Brewer, W. H.: "Report on the Occurrences of Iron Ore Deposits on Vancouver and Texada Islands, B.C."; Ann. Rept., Minister of Mines, B.C., 1916, pp. 296-299. *Also* Ann. Rept., 1923, p. 258.

Whittier, W. H.: "An Investigation of the Iron Ore Resources of the Northwest"; Univ. of Washington, Bureau of Industrial Research; Bull. No. 2, pp. 35-47 (1917).

Stansfield, A.: "The Commercial Feasibility of the Electric Smelting of Iron Ores in British Columbia"; Dept. of Mines, B.C., Bull. No. 2, 1919, p. 31. An estimate of the available tonnage of iron ore.

Swanson, C. O.: "The Genesis of the Texada Island Magnetite Deposits"; Geol. Surv., Canada, Sum. Rept. 1924, pt. A, pp. 106-144.

GENERAL GEOLOGY

The following account of the general geology is quoted from the report by R. G. McConnell.[1]

"The iron ore occurs in the form of magnetite lenses of various sizes, distributed irregularly over an area about 1½ miles in length and half a mile in width. The magnetite belt roughly parallels the coast at a distance from it of from a quarter to half a mile, and most of the occurrences outcrop at elevations of from 300 to 500 feet above sea-level. The sloping surface is drift-covered in places up to an elevation of about 350 feet, but over most of the area the hummocky rocks are bare or only lightly covered and the geological boundaries are easily traceable. The magnetite lenses often project as low hills.

The rocks represented in the iron range consist of limestones intruded successively by porphyrites, quartz diorite in stocks and dykes, and diorite porphyrite dykes.

The limestones occupy an irregular area along the northern elevated part of the range. Ordinarily, they are light to dark grey rocks with a compact to saccharoidal texture, but in places, especially near the intrusive masses, have been altered into coarse, whitish, crystalline marbles. The bedding planes have mostly disappeared and the principal partings consist of well-developed cleavage planes inclined at high angles. . . . The limestones here, as elsewhere on the island, are remarkably free from impurities, except for the development of secondary minerals and occasionally some chert along the contacts with the intrusives. They occupy the most elevated portion of the district and in places have the appearance of overlying and being younger than the porphyrites. The actual contact of the two rocks is usually marked by a hollow partially filled with debris and is seldom seen, but at a few points unmistakable evidence of the intrusion of the porphyrites into the limestone is clearly exhibited.

The porphyrites occupy a small area at the southwestern corner of the area and a large one indented by a limestone spur from the north at the eastern end of the mineralized area. They are greyish, medium-grained, holocrystalline rocks. . . . . and while classed generally as porphyrites in some of their phases they resemble andesites, and in others, diorites. . . . The porphyrites are always more or less altered, usually with a development of epidote, but nowhere to such an extent as to obscure their origin. . . .

The quartz diorites are intrusive into both the limestones and porphyrites. They are distributed over an irregular roughly triangular area, stretching inland from the coast for a distance of about a mile. In addition to the main area, a number of dykes and small stocks cut the bordering limestones and porphyrites. The quartz diorites are greyish, irregular-textured, but seldom coarse, rocks. . . . Secondary minerals, principally epidote, garnet, and magnetite, occur abundantly in the quartz diorites, near their contacts with the bordering rocks and occasionally replace them altogether over small areas. . . .

The diorite porphyrites, the latest intrusives in the area, occur in the form of dykes. . . . They are common in the limestone . . . . and less frequent in the quartz diorites and porphyries. . . . Diorite porphyrite dykes were intruded both before and after the mineralization of the district."

[1] Op. cit., pp. 75-77.

DESCRIPTION OF THE ORE OCCURRENCES

The main outcrops of the magnetite ore-bodies of the Prescott mine (*See* Figure 16) occur on a hill-side about 600 feet from the seashore and at elevations of 400 to 600 feet. The ore-bodies occur at the contact of limestone and quartz diorite and lie mainly within an area of much altered quartz diorite. The upper slopes are underlain by limestone. On the lower slopes of the hill, away from the ore-bodies, the quartz diorite is a normal, unaltered rock, but approaching the ore-bodies it shows many signs of alteration and in the immediate neighbourhood of the ore masses the diorite is largely replaced by secondary minerals such as epidote and magnetite. In places the rock is so rich in magnetite, occurring either irregularly distributed throughout it or in part concentrated in masses, some of large dimensions, as to constitute what might be termed a low-grade iron ore. Within the area of most highly altered diorite occur the ore-bodies, consisting mainly of magnetite but accompanied by various silicates and by masses of incompletely replaced rock. In one instance, an ore-body occurs resting on limestone.

The ore masses have been partly developed and worked by open-cuts and by a long tunnel entering the hill-side at an elevation of 165 feet and ending at a point nearly beneath one of the large ore-bodies visible on the surface. At an elevation of about 490 feet, a quarry face has been opened with a length in an east and west direction of 100 feet. The quarry is open to the south. The north wall rises steeply for 70 feet or more and consists of limestone and irregular bodies of magnetite, in part connected with one another, in part in isolated masses, and they vary in size from such as are small patches to others several or more yards in width. No attempt has been made to mine these masses; they give no evidence of forming bodies of size large enough to warrant mining and possibly are only root-like projections of a once continuous mass since removed by mining. At the summit of the eastern part of the quarry face, at an elevation of 70 to 90 feet above the quarry floor, magnetite outcrops over an area about 100 feet long by 40 feet broad. This mass is a remnant of a body of ore which in times past afforded much of the ore shipped. At one time it apparently extended down to the quarry floor, and rested on the steeply inclined face of limestone now forming the wall of the quarry (*See* Figure 16, section F-G). The body of ore still remaining appears to be a shallow mass presumably nowhere much more than 10 feet thick.

At its western end the quarry working extends into a southward projecting spur of the hill, so that there are rock faces on the north, west, and south sides. The limestone forming the north wall of the quarry extends into the west part, but is there replaced by altered diorite. The two rocks are in sharp contact, divided by a nearly vertical plane. To the west, after a space of a few feet, the altered diorite is succeeded by still more highly altered diorite impregnated with much magnetite. This more highly altered rock occupies the west and south face of the pocket-like extension of the quarry and with a width of about 50 feet extends westward upward and over the ridge dividing the quarry from a second open working yet to be described. On the west face of the pocket-like extension of the quarry, the rock face for a breadth of about 25 feet at the level of the quarry floor is occupied by ore and this mass extends up the nearly vertical west quarry face to an estimated height of 30 feet.

The width of the ore-body decreases upwards, so that in a vertical plane its outline is approximately that of a triangle with its base marking the level of the quarry floor. There is no evidence that much of this ore-body has been removed. It appears to be the upper part of the eastern face of a body that may extend westward for some distance into the hill and downwards with perhaps increasing dimensions. On the other hand, it is possible that this body is of small dimensions.

The zone of heavily mineralized diorite, in part a low-grade iron ore, described as commencing at the western end of the pocket-like extension of the quarry, extends westward up and over a southward projecting spur of the main hill. The belt of altered rock at first has an average breadth of 50 feet and maintains this for a distance of 80 feet to a point where it commences to expand and, bending to the south, attains a maximum breadth of 170 feet and encircles a large body of magnetite developed by a second quarry opening. The floor of this quarry is at an elevation of 420 feet. The quarry extends northward into the hill for a distance of 70 feet, with a width increasing at the inner face to 40 feet. In the north-east angle of the quarry, a tunnel expanding into a chamber extends 30 feet farther north and is all in ore. The east and west sides of the quarry approximately mark the boundaries of the ore mass which is roughly oval or pear-shaped of outline with a major axis, running northward and 145 feet long, and a minor axis, 65 feet long. The inner north face of the quarry is of ore occupying a steep, in part precipitous, slope on which the north end of the ore-body lies 125 feet above the quarry floor. In plan, the area of the ore-body measures 7,500 square feet. On its eastern side, the mass of ore is rather sharply divided from the bordering zone of highly altered, magnetite-impregnated diorite. On the west side, the distinction between ore and rock is less sharply drawn and there for a breadth varying from 20 to 80 feet the bordering rock is rich in magnetite and holds masses of nearly pure iron ore 20 to 30 feet in diameter.

The outcrop of the second ore mass is 100 feet west of the body of ore visible in the west end of the first-described quarry working. The two ore-bodies are connected by the 50-foot wide band of magnetite-rich rock, but otherwise at the surface form two distinct ore-bodies in part separted by a mass of relatively little altered diorite.

In front of the second-described, lower quarry, the hill-side below for a breadth of 100 feet is covered by waste rock and ore from the quarry. This material conceals a considerable area of what is probably highly mineralized rock, since to the west at the lower edge of the waste-covered area, and higher up the hill above the dumps, highly mineralized rock is visible with here and there patches and bodies of nearly pure magnetite, some above 50 feet in length. This highly mineralized area extends westward for 300 feet and ends against a large, drift-covered space extending southward from the edge of the higher of the two quarry workings. Outside this heavily mineralized area, the quartz diorite in places shows alteration in a varying degree and in several places was seen to hold small masses of magnetite.

Down the hill-side, at a point 162 feet above sea-level, a tunnel 617 feet long has been driven northward along a varying course. Throughout its length to within 80 feet of its end, the tunnel walls show practically unchanged quartz diorite save at a point 400 feet from the end, where for a length of 10 feet a narrow band of magnetite, garnetite, etc., is visible.

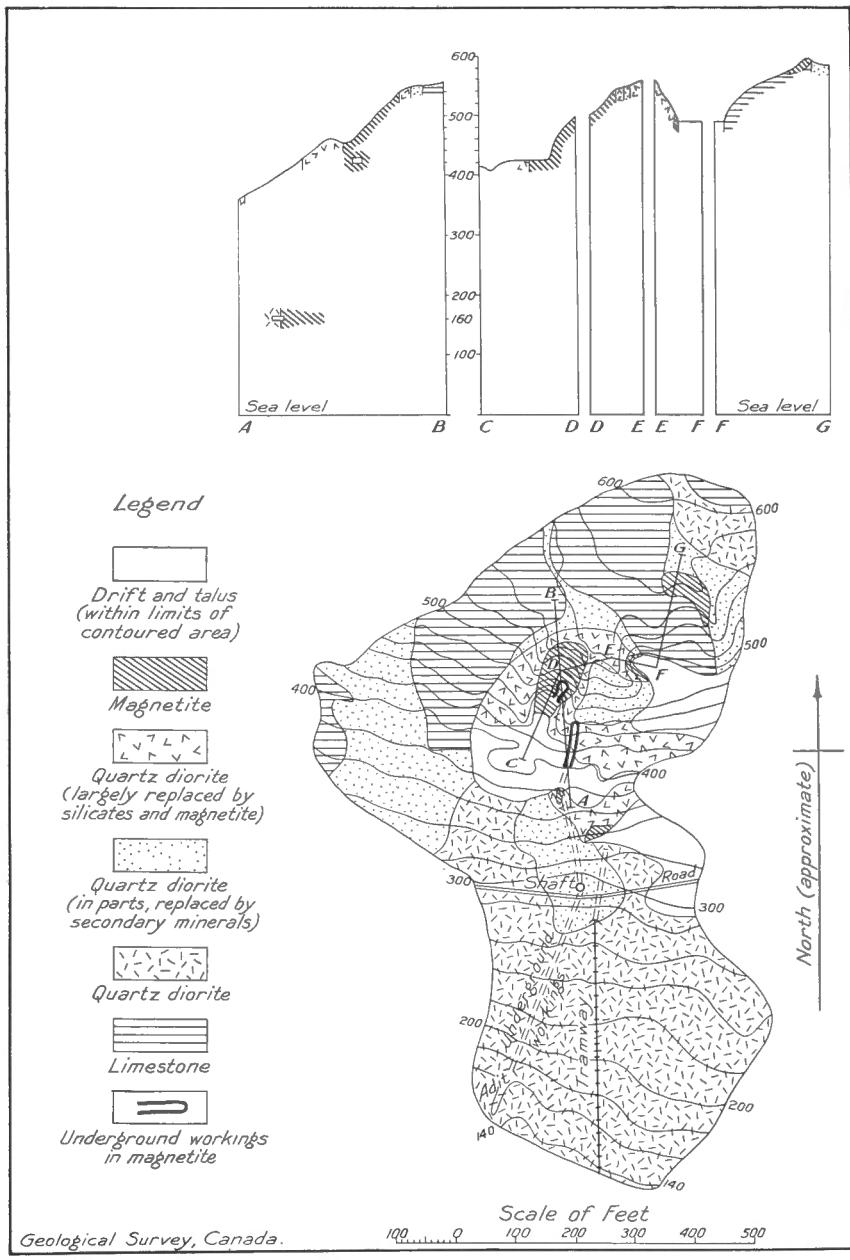

Figure 16. Magnetite deposit, Prescott mine, Texada island, B.C. Contour interval, 20 feet.

This mineralized occurrence lies 200 feet below the west edge of the heavily mineralized rock as exposed at the surface. The end of the tunnel is cut in magnetite wh ch shows solidly along the west wall for 75 feet and for 45 feet along the east wall. The face of the tunnel is in magnetite and lies 300 feet beneath the surface and, in plan, 45 feet west of the west edge of the large ore-body in which the lower of the two quarries has been opened. The ore penetrated by the tunnel lies beneath the zone of highly mineralized rock exposed at the surface, but not beneath the outcropping of the ore-body. There is no direct evidence that the ore in the tunnel and that at the surface belong to one continuous mass.

The character of the ore exposed in the western, lower quarry is as follows, as stated by McConnell.[1]

"The magnetite is coarsely crystalline, breaks with a rough fracture, and is seldom free from impurities. Marcasite in thin, short, radiating plates concentrated in places along narrow bands resembling veinlets, is conspicuous from its contrasting colour, although the percentage present is small. Some pyrite is also present, and occasionally garnet and chalcopyrite. The non-metallic impurities include dark areas made up mostly of epidote, garnet, and hornblende, and a number of small, light-coloured areas filled mainly with calcite and quartz. The latter are considered to be cavities formed during the crystallization of the magnetite and subsequently filled up. They are usually lined with garnet and contain some epidote and occasional cubes of pyrite in addition to the main calcite-quartz filling."

In the steep face of ore on the north wall of the lower quarry, well within the ore mass, the dark areas referred to by McConnell and which apparently represent altered country rock, vary in size from mere specks up to others 1 to 2 yards in diameter. Calcite is also conspicuous in specks and splotches, some several feet long. The proportion of this barren material to ore is difficult to estimate, but by area it would seem to lie between 1 to 8 and 1 to 4. Areas of the ore are especially rich in sulphides, others are nearly free of this material, but in general at least a speck of sulphide is visible in each area of 4 square inches. The ore penetrated by the tunnel resembles that found at the surface save that it seems to carry much smaller quantities of sulphides and waste materials. A sample across the face of the tunnel was taken and assayed by Whittier; the results are given in column 1 below. "An average sample . . . . along the tunnel" taken by Lindeman gave the results presented in column 2 below. A "general sample along the 75 feet of magnetite exposed in the lower tunnel" taken by McConnell, yielded the results shown in column 3.

—	1	2	3
Fe	60·30	63·27	55·20
S	0·07	0·347	0·266
P_2O_5	none	0·013	.....
SiO_2	7·90	4·37	.....
Al_2O_3	.....	1·18	.....
CaO	.....	2·58	
MgO	.....	1·05	.....
Cu	.....	0·09	0·14

[1] Op. cit., p. 83.

The Paxton ore-body lies three-fourths mile east of the Prescott, on the western edge of the quartz diorite body where it is in contact with a large area of porphyrite extending far to the east. The ore-body seems to be wholly within the quartz diorite. The ore outcrops (*See* Figure 17) on a steep slope 70 feet high and extends a short distance back on the top of the rise. The south, east, and west boundaries are rather sharply defined, but the north boundary can be only arbitrarily drawn, since in a northerly direction the ore grades into heavily mineralized diorite. The only development work performed on the property consists of two open-cuts, made at the foot of the south slope and extending into the hill, and a tunnel 43 feet long driven from the end of one of the open-cuts.

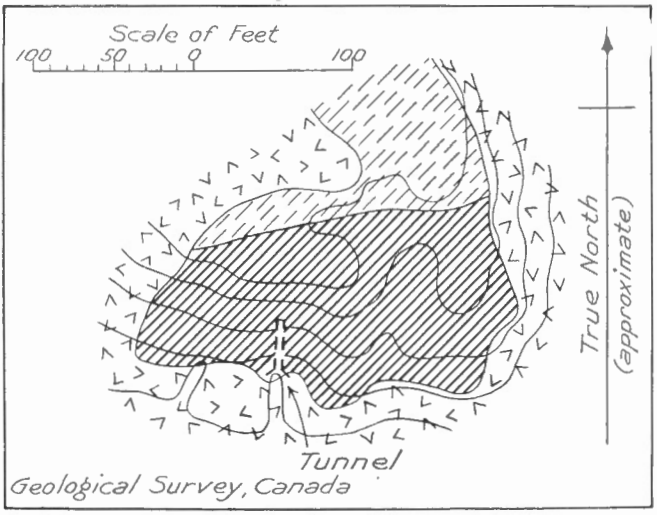

Figure 17. Magnetite deposit, Paxton mine, Texada island, B.C. Magnetite shown in ruling; quartz diorite (largely replaced by silicates and magnetite) in broken ruling; and quartz diorite in angle pattern. Contour interval, 20 feet.

In outline the ore-body is approximately four-sided. The south boundary extends nearly due east and west and is 250 feet long; the east boundary is 160 feet long; the north boundary is 260 feet long; and the west boundary is 100 feet long. The area of the body is 38,000 square feet.

McConnell describes the ore in the following terms.

"The Paxton ore is coarse-grained, contains the usual small areas of dark secondary minerals and a larger percentage of sulphides, mostly iron pyrites, than usual. Part of the ore mined from the tunnel some years ago and since exposed to the atmosphere has crumbled into grains owing to the decomposition of the numerous pyrite crystals. An assay of a sample taken along the tunnel yielded: iron 59·40 per cent, copper 0·30 per cent, sulphur 1·07 per cent."

In the vicinity of the south boundary, much sulphide is visible, but elsewhere little or none was seen. Over the western two-thirds of the exposures there is visible much barren material, in part, at least, unaltered, partly replaced diorite. Such material in one place along the steep south face outcrops nearly continuously for a length of 200 feet and with a variable breadth in places measuring 5 feet. In the northern part of the

western half of the ore mass there are many barren ovoid rock masses 1 to 3 feet in length. In the heavily mineralized area bounding the ore-body on the north, in the narrow western part (*See* Figure 17) the rock is diorite only little altered and in it the magnetite seems mainly concentrated in one irregular body, in places 10 feet broad, and which extends east and west with a length of 100 feet. In the extension of this mineralized area continuing northward, the diorite is, on the whole, more highly altered and magnetite forms separate bodies some of which may be 40 feet long.

The Lake ore-body (*See* Figure 18) is about one-third mile east of the Paxton and lies within the porphyrite area at the contact with limestone that extends northward. The body outcrops on ground rising to the north, the difference in elevation between the lowest and highest parts of

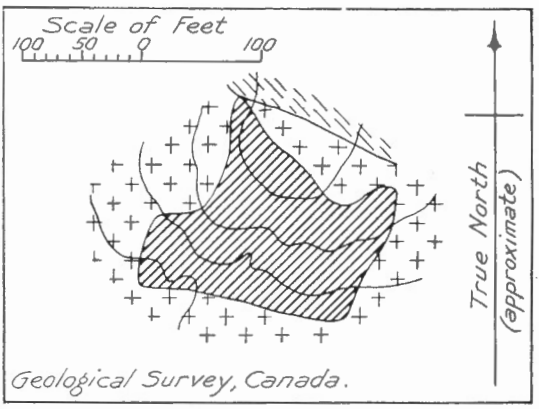

Figure 18. Magnetite deposit, Lake mine, Texada island, B.C. Magnetite shown in ruling; porphyrite in crosses; and limestone by broken ruling. Contour interval, 20 feet.

the ore-body being about 65 feet. The boundaries of the ore mass are fairly well defined. The outline of the body is somewhat irregular, but on the whole is roughly quadrilateral with a maximum length and breadth of 170 feet. The exposed area measures 20,800 square feet. Several open-cuts have been made along the south edge of the ore outcrop, but otherwise no development work has been done. The general nature of the ore mass is, as expressed by McConnell, as follows.

"The magnetite in the Lake mine ore-body is finer-grained than in the other large masses and is freer from iron and copper sulphides. These have developed in considerable quantities in the altered zone lying between the main magnetite mass and the unaltered limestone (on the north) and occur only in scattered grains and minute aggregates in the magnetite itself. Non-metallic impurities, principally epidote and garnet, and less frequently actinolite, calcite, and quartz, are fairly abundant. A rough general sample taken from the faced magnetite cliff . . . . yielded: iron 57·50 per cent; copper, trace; sulphur 0·046 per cent."

Along the western part of the south boundary and for a considerable distance away from it, the ore carries much finely disseminated silicates, some calcite, and an occasional sulphide grain. Small spots and splotches of coarsely crystalline magnetite and garnet with interstitial calcite are

noticeable. Eastward along the south boundary the grade of the ore improves and continues to be of better quality along the east and north edges. On the west side, the condition is much the same as along the

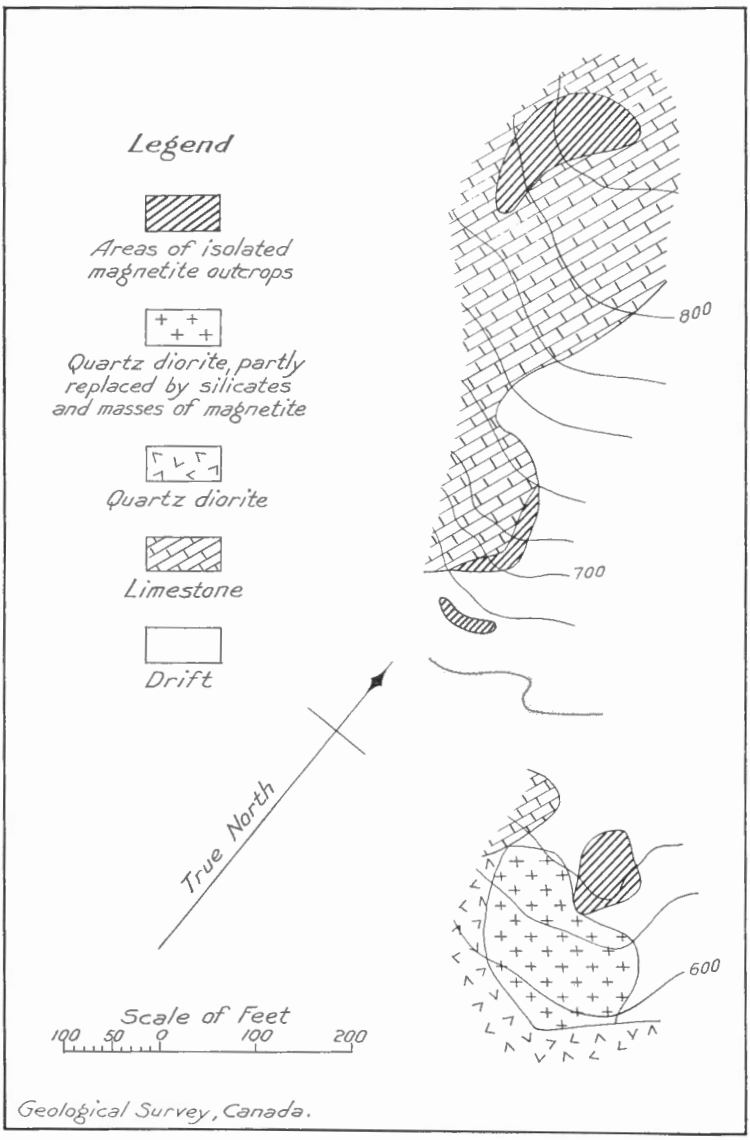

Figure 19. Magnetite occurrence north of Prescott mine, Texada island, B.C. Contour interval, 20 feet.

south edge, but on the whole little or no sulphide is visible. Towards the centre of the mass, the ore is of better quality, the silicates are less abundant and are more evenly dispersed.

In addition to the three main ore occurrences, magnetite ore is present at a number of localities. Only one of these occurrences was more than cursorily examined by the present writer. This place lies a few hundred yards north of the Prescott mine. At it (*See* Figure 19) isolated outcrops of magnetite project through drift in three places, of which the westernmost has an area of 9,600 square feet, but all of this may not be underlain by magnetite.

The various minor occurrences are described by McConnell as follows:

"West of the Prescott mine, a number of magnetite lenses of moderate sizes occur along the diorite-lime, and farther on the porphyrite-lime contacts, the larger having a length of 90 feet and a width of 20 feet. Lenses have also formed at a few points along the small, outlying diorite stocks and dykes. A lens 57 feet long and 20 feet wide occurs at one point, forming the continuation of a diorite dyke. The magnetite in this lens is remarkably free from both sulphides and non-metallic impurities. . . .

North of the Prescott mine, the lime-diorite contact is exceedingly irregular, consisting of a succession of spurs and bays. Three large and several small lenses of magnetite occur in one of the limestone bays. (This is the locality of Figure 19, *See* above.) The most westerly and largest of these has formed entirely in limestone at a distance of 100 feet from the tip of the diorite spur. It has a length of 250 feet and an average width of about 50 feet. The second lens has a length of 160 feet, a width of 40 feet, and has formed along the contact. The third lens has developed partly in diorite and partly in limestone and has a length of 200 feet and a width of about 70 feet. The diorite southeast of this lens is altered and replaced for some distance by epidote, garnet, and grains and bunches of magnetite. No work has been done on these lenses except the excavation of a small pit at one point. The ore, judging from the surface exposure, is of superior quality, and the percentage of sulphides is very small.

Southwest of the Prescott a mineralized area in the quartz diorite, about 75 feet across, is exposed in a cut on the tramway (since destroyed) from the mine to the coast. The area contains a narrow lens of magnetite, but consists mainly of epidote, garnet, and small bunches of magnetite. The percentage of sulphides present, mostly iron pyrites, is high.

The Paxton ore-body occurs at the southern extremity of a long, altered area consisting mainly of epidote, garnet, and magnetite, in grains and bunches, situated on the south along a diorite-porphyrite contact. To the north, the two intrusives are separated by a limestone spur and the altered area divides into two portions, the easterly one following the porphyrite and the westerly one the diorite. The latter spreads southward at one point into the diorite for a distance of 500 feet. It contains several lenses of magnetite of good quality from 50 to 75 feet in length. The easterly branch also holds some moderate-sized magnetite lenses and near its termination small lenses of chalcopyrite, several of which have been mined, occur in the limestone.

The lime-diorite contact farther to the north is marked at intervals by small magnetite lenses and areas of the alteration, and at one point the diorite at some distance from the contact is completely replaced by a mass of secondary minerals. The replaced area is crescentic in shape and has a length of 300 feet. It contains two magnetite lenses, each about 60 feet in length, and numerous small aggregates and bunches associated mainly with epidote and garnet.

The porphyrite east of the Paxton extends northwards as a spur from the main body penetrating the limestone. East of the tip of the spur, a rounded mass of magnetite about 90 feet across has formed in the limestone, and several smaller lenses, one at the porphyrite-lime contact, occur to the south. The mineralized area is here cut across by a large diorite-porphyrite dyke.

A buried lens of magnetite about 30 feet in width was cut through in the copper workings at the Lake mine, 250 feet northeast of the main magnetite ore-body. The lens is overlain by crystalline limestones practically free from secondary minerals.

A line of narrow magnetite lenses about 1,000 feet in length, simulating an interrupted vein, occurs south of the Lake mine in the porphyrite at a considerable distance from both lime and diorite contacts. The conditions are unusual as the porphyrite near the magnetite shows little alteration and non-metallic secondary minerals are rare. The most northerly lens, the longest one, measures 220 feet in length with a width of from 10 feet to 20 feet. Two other lenses measure respectively 84 feet and 50 feet in length, with widths of from 10 to 20 feet. The other lenses are comparatively small. The magnetite in all the lenses is fine-grained and remarkably pure. Some epidote and garnet occur scattered through it, but the quantity is small and only occasional grains of pyrite were noted. . . ."

MODE OF ORIGIN

Dawson[1] at an early date recognized that the magnetite ore was one of the results of the intrusion of the mass of quartz diorite and that the bodies occurred variously within the diorite, the porphyrite, and the limestone. Leith[2] states that the ores . . . ."are obviously replacements of limestone. In some instances the ore may be seen entirely surrounded by igneous rock, evidently a replacement of limestone intruded by and caught up in igneous rock near the contact" . . . . The same author[3] cites the Texada ore-bodies as examples of the "pegmatite type" of iron ore deposits. Ores of this type are defined by him as being such as . . . "are carried to or near the surface in magmas and are extruded from them, in the manner of pegmatite dykes, after the remainder of the magma has been partially cooled and crystallized. They are deposited from essentially aqueous solutions mixed in varying proportions with solutions of quartz and the silicates."

McConnell[4] states that . . . . "the iron and associated copper ores . . . . are typical examples of contact metamorphic deposits. . They occur along the lime-diorite contacts, the lime-porphyrite contacts, the porphyrite-diorite contacts, and enclosed in all three formations at considerable distances from the boundaries. . . . They originated during the closing stages of the Coast Range batholith invasion. . . . While the main mass of the metallic minerals probably formed after the non-metallic ones (epidote, garnet, pyroxene, etc.) there is reason to believe that the deposition of both kinds was taking place at the same time in different parts of the mineralized area, and that small quantities of non-metallic minerals continued to form until deposition finally ceased". . .

[1] Dawson, G. M.: Geol. Surv., Canada, Ann. Rept., vol. II, pt. B, p. 37 (1887).
[2] Leith, C. K.: U.S. Geol. Surv., Bull. 285, p. 196 (1906).
[3] Leith, C. K.: Jour. Can. Min. Inst., vol. 11, pp. 92-93 (1908).
[4] Op. cit., pp. 77, 78, and 81.

Although evidence is not at hand to prove beyond doubt that the ore-bodies replace both diorite and porphyrite as well as limestone, yet the field evidence strongly substantiates this view. In numerous instances both within and close to the ore masses, it is possible to observe what appears to be examples of all stages in the replacement of respectively diorite and porphyrite and at the same time there is a complete lack of any direct evidence of the former presence of limestone.

ECONOMIC CONSIDERATIONS

At the Prescott mine there has been exposed a number of bodies of magnetite occurring within a limited area. A nearly worked out mass resting on limestone occurs in the east, high up on the face of the highest open working. This body gives no prospect of affording any considerable amount of ore.

A second ore-body is partly exposed in the hill-side at the west face of the higher quarry. It possibly extends for some considerable distance westward into the hill over which outcrops highly altered diorite, in part richly impregnated with magnetite. The body may extend downwards with expanding dimensions; it may connect with the large magnetite body exposed less than 100 feet to the west. There is, however, no available evidence indicating that the mass of magnetite may be anything more than a relatively small body.

The large body of magnetite in which the lower quarry has been opened has an area of 7,500 square feet. The boundary on the east side follows a nearly vertical plane to a height of at least 60 feet and it is possible that all boundaries are essentially vertical, that the shape of the mass is pipe-like, and that it extends downwards along a general vertical direction. From the floor of the quarry to the highest part of the mass is 125 feet. The amount of ore partly developed above the floor of the quarry, assuming the boundaries to be vertical, is estimated to be not greater than 50,000 tons. The depth to which this body may extend is unknown. Some who have examined this deposit[1] are of the opinion that this body extends downward to unite with the ore struck in the end of the tunnel 255 feet below the level of the quarry floor. One former observer[2] on the other hand states . . . . . "sufficient development work has not been done to determine if the bodies exposed in the quarries are connected with one another and with the one in a tunnel". . . . An inspection of the plan and sections of the mine (Figure 16) reveals that the ore penetrated by the tunnel lies in front of and to one side of the exposure of ore at the surface. Where the tunnel enters the ore-body the boundary of the ore mass follows a general northeasterly course and it is not improbable, therefore, that the body of ore extends a considerable distance to the west and, also, since the tunnel face is still in ore, it is also possible that the mass continues northward a considerable distance. If both possibilities should prove to be actualities, a considerable part of the

[1] McConnell, R. G.: Op. cit., p. 88.
Lindeman, E.: "Iron Ore Deposits of Vancouver and Texada Islands, B.C."; Mines Branch, Dept. of Mines, Canada.
Brewer, W. M.: "Iron Ore Deposits on Vancouver and Texada Islands, B.C."; Mines Branch, Dept. of Mines, Bull. No. 3, p. 32.
Whittier, W. H.: "An Investigation of the Iron Ore Resources of the Northwest"; Univ. of Washington, Bureau of Industrial Research, Bull. No. 2.

[2] LeRoy, O. E.: "Preliminary Report on a Portion of the Main Coast of British Columbia and Adjacent Islands, etc."; Geol. Surv., Canada.

ore mass of the tunnel may be vertically below the body outcropping at the surface. Such a condition would give further weight to the opinion that the ore exposed at the surface and in the tunnel belong to one and the same body, but would not demonstrate this to be the case, since there is no doubt that in the general area masses of magnetite abruptly end or grade into impregnated rock not rich enough in magnetite to constitute ore. If it be assumed that the ore masses at the surface and in the tunnel belong to one continuous body of uniform cross-section, then the ore-body between the level of the quarry floor and that of the tunnel, would contain in the neighbourhood of 300,000 tons. McConnell, making the same assumption, estimates that the tonnage would be 1,366,400 tons, but this estimate is based on the view that the ore-body at the surface has a length of 300 feet and an average width of 80 feet. The adoption of surface dimensions as large as this involves including much low-grade rock and considerable barren diorite. The view advocated that the ore-body is much more limited in size is corroborated by the results of an examination of the property made for the owners by F. H. Shepherd and published in the form of a map accompanying a report by Lindeman.[1]

In the case of the Paxton ore-body, practically nothing is known beyond its surface extent. The two open-cuts at the foot of the south face show that for a vertical space of a few feet the boundary is vertical. Possibly the boundaries everywhere are vertical or nearly so. It would seem safe to assume that the mass everywhere continues downwards to at least the level of the foot of the south face. Making such an assumption, the amount of ore in all probability would not be less than 300,000 tons.

The Lake ore-body outcrops with an area of 20,800 square feet. Practically no development work has been done in connexion with this mass. The contacts seem to be vertical planes and it seems reasonable to assume that ore extends in depth to at least the level of the lowest point now visible on the south face. Under this assumption, at least 90,000 tons of ore might be considered present.

The total amount of ore that, with varying degrees of probability, it seems permissible to assume as probably present in the Prescott, Paxton, and Lake deposits, is, in round numbers, 700,000 tons. This quantity, however, may not be all first-class ore. Writing in 1902, Carmichael[2] stated with reference to the operations then being conducted on the Prescott ore-bodies that . . . . "as the ore is mined on royalty, only that running 50 per cent iron, or over, is shipped. With such sorting, only about half of the ore mined is shipped". . . . McConnell estimated that the Prescott, Paxton, and Lake bodies might contain in the neighbourhood of 3,500,000 tons provided that the bodies . . . . "extend downwards for a distance equal to their exposed surface length" . . . . but the same author is careful to state that the ore-bodies are of a type which . . . . "are characteristically irregular and uncertain in outline. Furthermore, the district has been subjected to almost continuous erosion . . . . (for an extremely long period of time and consequently the ore-bodies) have been partly destroyed, and the portions remaining may represent either the roots or the tips of large masses" . . . . Another estimate of the ore tonnage is given by Stansfield[3] who from notes furnished him by the B. L. Thane Company,

[1] Op. cit.
[2] Carmichael, H.: Ann. Rept., Minister of Mines, B.C., 1902.
[3] Department of Mines, B.C., Bull. No. 2, p. 31 (1919).

of San Francisco, states in reference to the holdings of the Puget Sound Iron Company, that . . . . "the deposit contains 1,000,000 tons and probably an additional 2,900,000 tons."

The present estimate of 700,000 tons of ore is not of developed ore, for there is practically no developed ore. The estimate represents the amount of ore that *probably* is present between the highest and lowest visible points of the individual ore occurrences It is unreasonable to suppose that ore does not extend below the lowest visible point, but no reliable means is available for estimating the depth to which ore is likely to extend. It is reasonable to hope, is perhaps reasonable to expect, that the amount of ore present is very much greater than the above figures indicate. Furthermore, in making this estimate, no attention has been paid to the probable or possible contents of the numerous, apparently, minor magnetite bodies whose general distribution and comparative sizes at their outcrops are indicated on a map accompanying the report by McConnell. A number of these occurrences are of such size and general characters as would warrant their being explored if a market for iron ore were established. It is not improbable that some of these occurrences would prove to be of very considerable magnitudes. Given a market for such iron ore as these properties would afford, there can be no question that conditions are such as would warrant the expenditure of a sum of money sufficient to determine the probable extent of the larger occurrences and of some of those occurrences that at present seem of minor importance.

Texada Island Iron Ore Deposits; Sundry Occurrences

The following accounts, derived from the report by R. G. McConnell[1], deal with various mineral occurrences on Texada island which, though not all strictly speaking iron ore properties, are yet of such characters as to render it possible that they might be of value as producers of iron ore wherever a market for iron ore is established.

"Texada island with the exception of the few small areas covered by Cretaceous deposits, is more or less mineralized throughout its whole extent. The mineral occurrences, while numerous and widely distributed, are mostly small and the proved important deposits are confined to two areas, one near Vananda on the east coast and the other almost directly south on the west coast. . . . The island has been subjected to nearly constant erosion since late Mesozoic time, and thousands of feet of massive and sedimentary rocks with their enclosed mineral contents have been worn away. The lenses of ore are irregular in shape and size, occur at varying depths, and the point at which they are intersected by the present surface is purely accidental. Small lenses cut through their widest part may make a better surface showing than large lenses, with only their tips exposed. . . .

"The Paris group of claims are situated a short distance south of Blubber bay, at the north end of the island. . . . The rocks on the claims consist of . . . . limestones intruded by two small diorite stocks and numerous diorite-porphyrite dykes. The stocks are highly altered. . . . The workings consist of three shafts from 50 to 60 feet in depth, the most southerly of which is connected with the surface by a tunnel 250 feet in length. The shafts have been sunk on moderate-sized,

[1] McConnell, R. G.: "Texada Island, B.C."; Geol. Surv., Canada, Mem. 58.

magnetite lenses formed along the diorite-lime contacts. The magnetite contains some irregularly distributed chalcopyrite, and also pyrite, pyrrhotite, and occasional grains of zinc blende. . . . At the central shaft about 200 tons of magnetite carrying considerable chalcopyrite has been mined. . . .

The Volunteer is situated about one-half mile west of the Marble Bay mine (at Vananda) near the southeastern end of a long diorite-porphyrite stock. . . . The croppings consist of three magnetite lenses from 30 to 50 feet in length and 10 to 15 feet in width, which have formed along the contact of the intrusive with limestone. The central lens rests below on limestone. It has been partly mined out and shipped as a flux. Some chalcopyrite is present, but the percentage is small.

The Red Cloud mine, formerly the Raven, is situated about one-quarter mile west of Spratt bay and 3 miles southeastward along the coast from Vananda. The croppings occur in . . . . porphyrite near a quartz diorite stock. . . . They consist mainly of magnetite containing some iron and copper pyrites and are distributed irregularly along a fissured zone from 1 to 8 feet in width, traceable along the surface for a distance of about 150 feet. The workings . . . . include a shaft . . . . and two drifts. . . . The lower drift extends from the . . . . surface . . . . for a distance of 254 feet, but does not reach the shaft. No ore is exposed along it. The upper drift extends from the surface to the shaft, and continues past it, following the lead for a distance of 70 feet. Magnetite occurs along it and a considerable amount has been stoped out and shipped as a flux. . . .

The Cape Sheaf is situated 2 miles south from Spratt bay. . . . The . . . . porphyrites holding occasional limestone inclusions and intruded in places by diorite porphyrites outcrop in the vicinity. The croppings consist of a magnetite lens formed in one of the inclusions near its contact with the porphyrite. A shaft has been sunk to a depth of 90 feet and some drifting done. . . . Dump specimens of the magnetite show some disseminated iron and copper pyrites. The grade in copper is not high.

The porphyrites extending from Raven creek, Spratt bay, northwestward for a mile or more . . . . are intruded near the coast by numerous quartz diorite stocks and hold numerous limestone inclusions seldom more than a few feet across. Many of the inclusions are partly replaced by secondary minerals and in a number magnetite lenses have developed. Among the best known claims in the district are the Woodpecker and Butterfly. The Woodpecker is opened up by a shaft and some open-cuts, all showing impure magnetite in small lenses. A shaft . . . . has also been sunk on the Butterfly to develop a magnetite lens 60 feet in length and from 4 to 6 feet in width. The magnetite in all the lenses contains considerable pyrite and some irregularly distributed chalcopyrite. . . A magnetite lens situated on the coast was mined. . . . and used as a flux.

The Malaspine Mines Company controls a large group of claims covering part of Comet mountain, east of Raven creek, and extending eastward to the coast a distance of over 3,000 feet. Comet mountain and the surrounding district are underlaid by the massive porphyrites. . . . cut by a few diorite porphyrite dykes, quartz diorite intruding the porphyrite outcrops in narrow stocks along portions of the coast. Small

inclusions of . . . limestone occur in places in the porphyrite. The croppings consist of a few magnetite lenses, the largest seen measuring about 100 feet in length. The magnetite contains some pyrite and small quantities of chalcopyrite, but is too low grade in copper to be considered an ore. . . .

The Good Hope fraction . . . . is situated on the south side of Raven bay about 250 feet from the coast. . . . The country rock is porphyrite cut by a few quartz diorite dykes. A magnetite lens 100 feet in length and from 5 to 15 feet in width has formed apparently in the porphyrite, but may replace a lime inclusion. The magnetite contains some pyrite and a small percentage of chalcopyrite, but is freer from impurities than most of the lenses in the vicinity."

Further details regarding the deposit on the Good Hope claim have been given by Brewer[1] who states that it has been developed on four levels. On the surface are two open-cuts each about 100 feet long and separated by a vertical interval of 20 feet. Lower down, a short adit was driven into the hill-side to the magnetite body below an exposure 20 feet lower than the lower open-cut. From the end of the adit, the ore has been stoped down over a length of about 100 feet. A fourth level was being driven in 1923 at approximately 75 feet below the outcrops on the surface. The magnetite body is stated to average about 11 feet in width, with, in places, a considerably greater breadth.

VANCOUVER MINING DIVISION

(25) Iron King, Alta Lake

Source of Information. Camsell, C.: "Reconnaissance Along the Pacific Great Eastern Railway between Squamish and Lillooet"; Geol. Surv., Canada, Sum. Rept. 1917, pt. B, pp. 21-22. Brewer, W. M.: "Ann. Rept., Minister of Mines, B.C., 1918, pp. 294-5.

GENERAL DESCRIPTION

Alta lake is on the Pacific Great Eastern railway about 35 miles north of its terminus at Squamish. In the vicinity of the lake are deposits of limonite. The rocks of the country side consist of deformed sediments and volcanics which form a wide band bordered by granitic rocks of the Coast Range batholithic area. According to Camsell, "A group of about twenty claims at one time covered an area at the north end of Alta lake where deposits of bog iron occur on the western slopes of the valley. All except four (controlled by Dr. Davidson and J. H. Thompson of Vancouver) . . . . have now been abandoned. The principal exposure occurs about half a mile west of the north end of Alta lake. Here on a heavily wooded slope a large number of trenches have been dug. . . . These trenches show the deposit to have a maximum thickness of about 10 feet, thinning out, however, on all sides. The area covered by the deposit is about 60,000 square feet, having a length of 450 feet and a greatest width of 250 feet. The top of the deposit is composed of loose, earthy material, whereas the bottom is hard and shows stratification. It is estimated that there are about 12,000 tons of ore in this deposit. . . . Other small areas of bog iron ore of similar character occur in the neighbourhood, but their extent is unknown. The iron ore seems to be derived from pyrite-bearing rocks which are exposed on the hill-sides above the deposits". . . .

[1] Brewer, W. M.: Ann. Rept., Minister of Mines, B.C., 1923, p. 258.

NEW WESTMINSTER MINING DIVISION

(26) Harrison Lake, Northeast Shore

LOCATION AND HISTORY

A group of five Crown-granted claims, owned by Mrs. Dixon, Vancouver, B.C., are situated along the northeast shore of Harrison lake about 17 miles from Harrison Hot Springs. The claims were acquired on the supposition that valuable deposits of iron ore were present on them and several pits, open-cuts, and three tunnels, have been made in an endeavour to develop the property.

GENERAL DESCRIPTION

The property was examined by R. E. Hayes and F. F. Osborne, field assistants, from whose report the following notes have been compiled.

Harrison lake is walled on both sides by steeply rising mountain slopes. In the immediate vicinity of the claims the lower slope rises in a series of step-like declivities along the lowest of which are the several tunnels and pits which have been opened on the claims. These workings are disposed over a length of 1,000 feet along the face of the first rise which is cliff-like, in part overhanging, and ascends abruptly to a height of 200 to 300 feet above the lake-level. Towards the east the workings lie within 100 feet of the shore. At the west limit they are distant 300 feet from the lake. The easternmost working is a tunnel open for a length of 50 feet to where it has caved in. West of this the workings consist of a shallow pit, a tunnel 26 feet long, two pits one 6 feet the other 15 feet deep, and a third tunnel 48 feet long.

The rocks in this vicinity as exposed along the lake shore and along the steep slope in which the various openings have been made, consist of highly fractured schistose sediments. The rocks on fresher surfaces are mostly dark slates and very fine-grained quartz sandstones or sandy shales with close-set schistose partings coated with colourless mica. An occasional bed is coarser-grained, paler coloured, and carries some carbonate in the matrix. The surface of the rocks of nearly every exposure is stained yellow, brown, or red by iron oxide which in places follows along parting planes to a depth of several inches or more. Small streams issuing from the talus at the foot of the first cliff-like rise and from the tunnels stain and coat their beds with iron oxide. The tunnel floors are covered with a limonitic mud in places nearly 1 foot thick, the walls are stained yellow, and here and there in the rock walls are small lenses of limonite. The largest lenses are only a few inches thick and several feet long.

The source of the limonite and other iron oxides has not been determined, but it is very apparent that no body of iron ore exists on the mining claims and that the limonite, etc., are products of weathering deposited on the surface, and along parting planes in the greatly fractured bedrock. Since the rock partings parallel the schistosity of the rocks, the streaks and small lenses of iron oxides parallel one another and present an appearance somewhat like that of beds or regular "leads." This deceptive appearance has led to the staking of the claims and, apparently, governed the plan of prospecting them.

(27) Tipella Mountain, Harrison Lake

LOCATION

Mr. J. G. West of Jubilee, and associates, have staked a number of mineral claims to include known outcrops of hematite on Tipella mountain which is situated just beyond the head of Harrison lake, on the west side of the valley in which the lake lies. The group of mineral claims is traversed by the steep-sided valley of Crazy creek, at this point flowing northeasterly. The valley floor within the area of the claims has an average elevation of 3,200 feet above Harrison lake. On its southeastern side the valley wall is continued upwards to the main summit of Tipella mountain; on the opposite, northwestern side the slopes rise 1,000 feet or more to a ridge on the flank of the mountain. The claims may be reached by a blazed line which commences on a rough road leading northwesterly along the continuation of Harrison Lake valley. The line begins about 500 yards from the wharf at Tipella and extends up the steep mountain side along the western edge of Crazy Creek valley.

GENERAL DESCRIPTION

No development work has yet been attempted on the claims. The outcrops of hematite-bearing rock are still in their original condition, are very few in number, and are not of large size.

On the southeast side of Crazy Creek valley, within the limits of the group of mineral claims, on the slopes of the main mass of Tipella mountain, small fragments of hematite, none more than 2 inches broad, were observed here and there amongst the materials of a rock slide to a height of 600 feet above the valley. It is said that narrow seams of hematite an inch or so wide have been found in place along a watercourse traversing this slide and that higher up the slope, at the top of the slide at a point perhaps 1,000 feet higher, seams of hematite an inch or 2 wide are observable.

On the opposite, northwest slope of Crazy Creek valley, at an elevation of 500 feet above the valley, a small knoll shows rock heavily mineralized with hematite for a width of 50 feet. The material has a banded appearance as if it extended in a north-northeasterly and south-southwesterly direction, but the total length exposed is not much above 50 feet. Along the apparent line of strike of the mineralized zone and only a short distance away, unmineralized rock outcrops, but it is said that at some little distance southwesterly, another showing of hematite has been discovered.

About 250 yards along a northwesterly direction from the showing on the knoll, hematite-bearing rock is exposed with a width of 30 feet, but along the strike is visible for only a few feet. If this mineralized zone is continuous with the first-mentioned occurrence, the zone must extend beneath a drift-covered area and make two abrupt bends, each approximating a right angle, because elsewhere large exposures of unmineralized country rock are visible.

About 200 yards along a northwesterly direction from the second-mentioned mineralized outcrop, is a third showing having a width of at least 50 feet and traceable along the strike for 100 feet to where bedrock is wholly concealed beneath drift. It is possible that the hematite-bearing rocks of the two last-mentioned outcrops belong to one continuous zone

having a length of at least 700 feet and a maximum width of not less than 50, and perhaps as much as 100, feet, since only one edge of the zone or zones is now visible, the southwestern edge being concealed under drift and the nearest outcrops of unmineralized rock lying a little distance away.

At each of the three mineralized outcrops, the material is of the same general character and has a streaked or imperfectly banded appearance. The individual, ill-defined layers seem to strike along the course thought to be followed by the mineralized zones and appear to be nearly vertical. In several places the mineralized rock grades outwardly into unmineralized country rock. The main mass in every case consists of micaceous hematite intermixed with a fine-grained gangue presumably representing much-altered country rock. The proportions of hematite and gangue material vary from band to band. The individual bands or streaks fade laterally into one another, are ill-defined, and are not continuous along the strike, but after continuing a few feet die away and are replaced by others of different characters. In places, individual streaks having widths of as much as several feet, but more often of only a few inches, are composed nearly wholly of hematite, but such streaks are exceptional and the rest of the material of the zones carries too little hematite to be of value.

The country rock seen on the lower slopes of Tipella mountain and up to the vicinity of the mineral claims is a normal granite, but on the southeast slopes of Crazy Creek valley within the area of the mineral locations, a band of schistose rocks is present and it may be that the hematite occurrences lie near a contact of granite with a large mass of older rocks, but there is no direct evidence of this being the case on the northwest slopes of Crazy Creek valley where the main showings of hematite are and where large exposures all of granite are visible. It is possible that the hematite has developed in patches of older rocks included in granite, but the material is now so much changed that it does not seem possible to determine whether the hematite has formed in isolated patches of foreign rock included in the granite, or whether, as seems probable, it has merely developed locally within the granite. The mineralized material has been produced by agents replacing and impregnating once barren rock. There is no reason for supposing that the mineralized matter materially changes in character at any moderate depth below the present surface.

The few limited outcrops unmistakably indicate that the mineralized zones as a whole do not consist of ore, but of rock impregnated in varying degrees with hematite. In places the hematite is sufficiently concentrated to constitute ore. This ore does not form continuous layers, but instead forms discontinuous streaks of no great length and so far as seen never wider than 3 or 4 feet. It is possible that in places these masses of ore may be of considerable thickness. It is stated that at one place ore shows through a thickness of 18 feet, but this particular occurrence could not be rediscovered. But supposing that in places ore does occur with widths of 18 feet or even more, there is every reason to suppose from what is now visible that the individual masses of ore would be lens-like, of no great length, and probably of no great depth. In all probability the tonnage content of any one lens-like mass would not be above 10,000 to 20,000 tons and it is probable that these larger bodies, if any exist, would be distributed so erratically within the mineralized area that mining would be unprofitable.

LILLOOET MINING DIVISION

(28) Lillooet Lake and Northwest

Source of Information. Cairnes, C. E.: "Pemberton Area, Lillooet District, British Columbia"; Geol. Surv., Canada, Sum. Rept. 1924, pt. A, pp. 76-99.

GENERAL DESCRIPTION

A wide band of highly deformed Triassic sediments and volcanics extends northwest from the head of Lillooet lake. Bodies of Jurassic or Cretaceous granodiorite, quartz diorite, etc., occur within the area of Triassic strata and border them on both sides of the band-like area. The granitic rocks are a part of the Coast Range batholithic area. In various places the strata have been mineralized. "The common type of ore mineralization . . . . . is the . . . . . replacement of limestone by . . . . . magnetite, hematite, pyrrhotite, pyrite, sphalerite, chalcopyrite . . . . . (etc.) These mineral deposits occur near some intrusive body regarded as having affected the metamorphism and mineralization of the limestone."

No mineral deposit yet found in the district appears to be large enough and pure enough to be classed as an iron ore deposit, but the type of mineralization is sufficiently like that found to the west along the British Columbia coast to suggest that large, comparatively pure bodies of magnetite may yet be discovered.

CLINTON MINING DIVISION

(29) Taseko River Area

LOCALITY AND HISTORY

Deposits of limonite, said to have been staked first in 1909, occur in the country drained by the headwaters of Taseko (Whitewater) river and in adjacent districts. The deposits in Taseko valley have been exhaustively reported upon by J. D. MacKenzie in the article referred to below and the summary account here given is derived from this report.

The deposits lie about 65 miles west-northwest of Lillooet. The best route to the district is by road from Shalath on the Pacific Great Eastern railway, to and up Bridge River valley for nearly 40 miles to where a trail following Gun creek leaves the wagon road. The Gun Creek trail in a distance of 40 miles reaches the head of the creek valley, crosses Taylor pass, and enters Taseko valley. The limonite deposits occur in the upper part of Taseko and in the valleys of several tributaries within an area of about 50 square miles.

The deposits have been referred to in the following reports:

Bateman, A. M.: "Exploration between Lillooet and Chilko Lake, British Columbia"; Geol. Surv., Canada, Sum. Rept. 1912, pp. 186-7.

Lindeman, E., and Bolton, L. L.: "Iron Ore Occurrences in Canada"; Mines Branch, Dept. of Mines, Canada, vol. 2, 1917, pp. 22-23. Referred to in part as the Chilcotin hematite mines. The account is derived from the report by Bateman and information supplied by an owner.

Brewer, W. M.: "Taseko Valley Iron-ore Deposits"; Ann. Rept., Minister of Mines, B.C., 1919, pp. 241-251. Contains detailed descriptions of the various bodies of limonite and estimates of the available tonnage of ore.

Crossland, F. J.: "Taseko Valley Iron-ore Deposits"; Ann. Rept., Minister of Mines, B.C., 1920, pp. 175-186. Contains detailed descriptions of the various bodies of limonite and estimates of the available tonnage of ore.

MacKenzie, J. D.: "The Limonite Deposits in Taseko Valley, British Columbia"; Geol. Surv., Canada, Sum. Rept. 1920, pt. A, pp. 42-70. A full account of the various bodies of limonite with estimates of available tonnage and accompanied by plans of the individual deposits.

GENERAL GEOLOGY AND DESCRIPTION OF THE ORE OCCURRENCES[1]

"The rocks underlying the limonite deposits are an assemblage of basaltic flows and pyroclastics with some quartz diorite porphyrite dykes and sills . . . . of Tertiary age . . . . (and overlie) unconformably the previously eroded surface of the great batholith of the Coast mountains . . . . (from which they dip away) at angles up to 25 degrees. . . . The Tertiary volcanic rocks also unconformably overlie another volcanic series which is apparently cut by the batholith".

"The deposits . . . . (of bog-iron ore) are situated in seven different localities. They consist of sheets of brown limonite of varying shape, size, and thickness, built up of thin layers of brown, cellular, and generally loose-textured limonite, lying parallel to the surface of the ground on which they rest. . . . The iron is derived from finely divided pyrite which impregnates greatly silicified and sericitized tuffs of the . . . . (Tertiary) formation. The iron sulphate solutions formed by the oxidation and leaching of this pyrite trickle down the mountain slopes and deposit (the iron) at the first favourable locality, building up a bed of limonite."

"The limonite deposits in Taseko valley are . . . . ; the Forrest deposit, located 6 miles from the source of Taseko river . . . . and half a mile east of the river . . . . ; Denain Creek deposit . . . . on Denain creek 4 miles above its junction with Taseko river; Feo, Rae, and Battlement Creek deposits . . . . ; the McClure Mountain deposits. . . . In area they vary from a few hundred to nearly a million and a half square feet, and each deposit as designated above, comprises several separated areas of limonite. . . . In thickness the limonite sheets range from a few inches to an ascertained dimension of 9 feet . . . . and it is probable that in some instances a thickness of from 12 to 15 feet may be attained. . . . The surface of the limonite beds where free from vegetation and not subjected to the action of one of the numerous streamlets which characterize the deposits, is covered with a loose . . . . gravelly ore layer. . . . up to a foot in thickness and . . . . doubtless due largely to the disintegrating action of frost. Below the loose surface layer the limonite lies in a coherent mass . . . . in layers slightly thicker with depth. . . . No minerals other than earthy limonite have been recognized in any considerable amount in these beds . . . . (which) are for the most part bare of vegetation. . . . The range in altitude . . . . (of the individual deposits) is from an elevation of 5,500 feet to over 7,300 feet . . . . ; no large beds are found above 8,400 feet. . . . Most of the beds lie on hill-sides of less than 15 degrees slope, many of them much flatter than this. They usually occur on the valley walls below where the steeper slopes flatten out into the more gently inclined bottom of the valley. . . ."

The . . . . "limonite beds occur as patches lying on top of the ground . . . . and . . . . their deposition is still in progress. . . . Their surface expression is such that they may readily be distinguished from areas underlain by till . . . . (and it is relatively easy to accurately determine) the outlines of the deposits". . . .

[1] The quotations are from the report by J. D. MacKenzie.

The tonnage of the various deposits, based on careful surveys and measurements of thickness as determined in various trenches and pits, was determined by MacKenzie to be as follows:

	Tons
Forrest deposit	81,450
Denain creek	22,000
Feo creek	17,500
Rae creek	10,500
Battlement creek	12,900
McClure Mountain deposits (two)	510,000
Near McClure mountain	15,000
Total	669,350

"Deposits of limonite similar (to the above) are reported from the vicinity of some of the headwaters of Big creek . . . . Prospectors . . . . state that they are thin and of small extent."

Analyses of a number of samples show the iron content to range between 44·0 per cent and 51·6 per cent.

Owing to the nature of the country to the south, a railroad to the area would have to enter the district from the north by following up Taseko valley from Chilko river, a distance of about 75 miles. . . . "From Chilko river a possible route . . . . (is by way of) Homathco river to Bute inlet on the Pacific coast."

ASHCROFT MINING DIVISION

(30) Thompson and Fraser Rivers above Lytton

Bodies of magnetite have been reported to occur at various places northward of Lytton on or near both Thompson and Fraser rivers. The available information for the most part has not been verified by the authors of the various published statements.

Dawson[1] states that it was reported to him that magnetite occurs "about 23 miles above Lytton, on the Fraser river, where the vein is reported to be 20 feet in thickness."

A sample of magnetite received by the Mines Branch[2] is said to have been obtained from the head of Nelson creek, 12 miles from Ashcroft.

Magnetite has been reported to occur on Thompson river east of Lytton at three localities, but possibly two or all three references are to the same occurrence. An iron-bearing deposit is said[3] to lie 10 miles east of Lytton. About 6 miles southeast (*sic*) of Lytton, on the east side of Thompson river there is . . . . "a group of claims on which there are a few showings of iron ore. The ore is magnetite, and it lies in layers between gneiss in a nearly horizontal position. The thickest bed is 19 feet and the others are much thinner"[4] . . . . The third reference is by Dawson[5] who states that a vein or irregular mass of magnetite accompanied by much pyrite outcrops in a ravine half a mile below Thompson, on Thompson river.

[1] Dawson, G. M.: "Report on the Area of the Kamloops Map-sheet, British Columbia"; Geol. Surv., Canada, 1895, p. 343.

[2] Lindeman, E., and Bolton, L. L.: "Iron Ore Occurrences in Canada"; Mines Branch, Dept. of Mines, Canada, vol. 2, p. 24 (1917).

[3] Ann. Rept., Minister of Mines, B.C., 1890, p. 378.

[4] Cleaves, L. B.: quoted in "Iron Ore Occurrences in Canada"; Mines Branch, Dept. of Mines, Canada, vol. 2, pp. 23-24 (1917).

[5] Dawson, G. M.: "The Mineral Wealth of British Columbia"; Geol. Surv., Canada, Ann. Rept., vol. III, pt. R, p. 151.

KAMLOOPS MINING DIVISION

(31 a) Glen Iron Mine

(*See* Figure 20)

LOCATION

The Glen iron mine is in Kamloops Mining division and is situated close to the south shore of Kamloops lake, 13 miles west of Kamloops or ½ mile east of Cherry Creek station on the Canadian Pacific railway. The ore exposures and various mine workings occur on a steep hill-side forming part of Cherry bluff which rises directly from Kamloops lake along whose edge the railway runs. The principal mine workings are about 1,200 feet from the lake shore and at an elevation of 400 feet above it. The property consists of 165 acres held under Crown grant as well as several mining claims. The owners are represented by Mr. F. J. Fulton of Kamloops.

HISTORY

The presence of veins of magnetite was known at a comparatively early date, but apparently the deposits were not acquired until 1889. Shortly thereafter shipments of ore were made to be used as a flux in copper smelters. Shipments ceased in 1902 after a total production of about 15,000 tons had been made and since that date the property has lain idle. During mining operations an open-cut 430 feet long was made along a vein-like body of ore. The open-cut varies in width from 10 to 20 feet and in places is more than 40 feet deep. It extends westerly uphill from a gully and towards its lower, easterly end a tunnel has been driven westward into and along the ore-body. The tunnel is 150 feet long and for the most part 15 feet wide. The ore above part of the length of the tunnel has been withdrawn from a stope whose height is unknown, but presumably is nowhere more than 40 feet.

The following is a list of the published accounts referring to this property.

Dawson, G. M.: "Preliminary Report on the Physical and Geological Features of the Southern Portion of the Interior of British Columbia, 1877"; Geol. Surv., Canada, Rept. of Prog. 1877-78, pt. B, pp. 117-118. Contains a generalized description of the deposits which are referred to as veins in an "extensive diorite mass". It is suggested that the veins may be of Tertiary age and have been produced during the last stages of the volcanic activity which gave rise to the Tertiary lavas of nearby areas.

Ann. Rept., Minister of Mines, B.C., 1890, p. 377; 1891, p. 574; 1892, p. 540; 1893, p. 1,068; 1894, p. 751; 1895, p. 698; 1896, p. 567; 1897, p. 614; 1898, p. 1104; 1899, p. 733; 1900, p. 890; 1901, p. 1,079; 1902, p. 163; 1903, p. 181; 1913, pp. 184-185; 1918, pp. 236-237; 1922, p. 149. Brief notices, for the most part indicating progress made in mining and development.

McEvoy, J.: (in) Geol. Surv., Canada, Sum. Rept., 1892, pp. 9-10. Contains brief notes on positions and sizes of outcrops of ore.

Dawson, G. M.: "Report on the Area of the Kamloops Map-sheet, British Columbia"; Geol. Surv., Canada, 1895, pp. 158 and 341-343. The ore-bodies described as veins; the country rock part of a large intrusive body of variable composition and considered . . . . "to indicate . . . . the site of a focus of volcanic activity of the Tertiary period".

Lindeman, E., and Bolton, L. L.: "Iron Ore Occurrences in Canada"; Mines Branch, Dept. of Mines, Canada, vol. 1, pp. 30-31 (1917). General statements regarding the mine workings.

GENERAL GEOLOGY

The ore occurrence lies in an area of plutonic rocks which according to Dawson[1] extends southeast for 10 miles with a width of 2 to 3 miles. Within this area, 8 miles to the southeast, are the analogous magnetite deposits of the Magnet, Moose, and other claims. The country rock where unaltered is dark grey, nearly black, of medium grain, with abundant dark-coloured constituents which include pyroxene, biotite, and magnetite. The rock is variable in composition and according to Daly[2] ranges from augite gabbro through augite diorite to monzonite. These rocks cut Triassic strata, but Daly states that their relation to the Tertiary volcanics is not evident and because the plutonics in places are considerably deformed, he is inclined to consider them as of Triassic age. Possibly, however, they are Jurassic. In the vicinity of the Glen mine, the plutonic rock in the immediate vicinity of the magnetite veins is, in places, altered to a rock consisting essentially of epidote, but which is accompanied in places by what appears to be tremolite or, in other places, serpentine.

DESCRIPTION OF ORE OCCURRENCES

So far as known the outcrops of ore are confined to an area extending 1,600 feet south from the lake shore and with a width increasing southward from 300 feet to 1,300 feet (*See* Figure 20). The ore consists essentially of magnetite with varying amounts of apatite and it occurs in vein-like bodies that follow curving courses trending east-west along the north face and top of a steeply rising hill which to the west suddenly ends. Outcrops of rock and ore are numerous, but not sufficiently so to permit the determination of the extent and courses of the individual veins which locally may be seen to follow curving courses, to swell, and to subdivide. In the following descriptions, the veins are dealt with in order from south to north and in the order of numbers assigned them (*See* Figure 20).

Vein No. 1. This vein is exposed in three places over a length of 140 feet. At its eastern exposure it is 5 feet wide, but at the most western outcrop it is only 9 inches wide and appears to end. This vein may extend some considerable distance west of its westernmost outcrop.

Vein No. 2. This vein is exposed at two places over a length of 160 feet. At its eastern outcrop the vein is 1½ feet wide and seems to end abruptly. At the west outcrop, the vein has about the same width and possibly continues to join with No. 3.

Vein No. 3. This vein is exposed at intervals over a length of 370 feet, sends off several branches, and possibly is continued westward by veins Nos. 4 and 5, in which case the total exposed length would be 770 feet. At the easternmost exposure, the vein is less than an inch wide and appears to end. At the next exposure, 70 feet west, the vein is 1 foot wide. Eighty feet farther along the strike the vein is 5 feet wide and is only several feet south of a body of magnetite 10 feet wide tapering to 1 foot in an easterly direction. This larger body presumably represents the eastern end of an enlarged part of the main vein; and from it a branch vein runs eastward

[1] Dawson, G. M.: "Report on the Area of the Kamloops Map-sheet"; Geol. Surv., Canada, Ann. Rept., vol. VII, pt. B (1896).

[2] Daly, R. A.: Guide Book No. 8, Transcontinental Excursion C 1, pt. 2, pp. 232-233; Issued by the Geol. Surv., Caanda, 1913.
"A Geological Reconnaissance between Golden and Kamloops, B.C., Along the Canadian Pacific Railway"; Geol. Surv., Canada, Mem. 68, pp. 140-141 (1915).

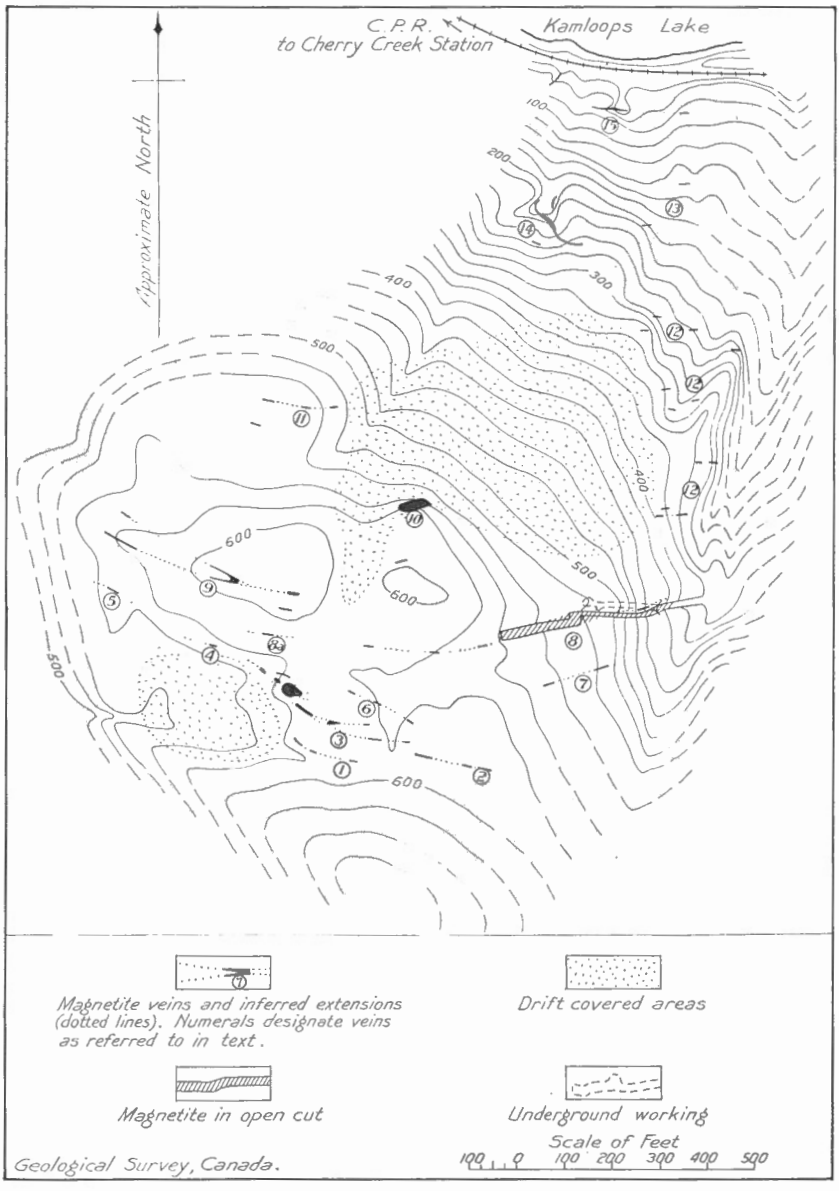

Figure 20. Glen iron mine, Kamloops district, B.C. Contour interval, 20 feet.

for 60 feet to where it is only 8 inches thick and seems to end. The main vein is exposed 75 feet to the west with a thickness of 5 feet and is exposed with this width at intervals over a length of 50 feet. Farther west along the vein the magnetite in one place has an exposed width of 20 feet and what appear to be one or more narrow branch veins are exposed to the south of it. The last exposures definitely assignable to No. 3 vein occur a little farther along the strike and there the vein is not more than 5 feet wide. Apparently at the two places where the vein forks, the ore mass notably increases in width, forming, it is estimated, one lenticular body 120 feet long and 25 feet broad and a second body 100 feet long with a thickness increasing gradually from 5 to 10 feet.

Vein No. 4. May be a continuation of vein No. 3. It has a width of about 2 feet, and is exposed over a length of 20 feet.

Vein No. 5. Vein No. 5, still farther west, is possibly a continuation, along a curving course, of vein No. 4. It has a width of 2½ feet and is exposed over a length of 30 feet. It is not known to outcrop to the west.

Vein No. 6. Vein No. 6 lies north of the eastern end of vein No. 2. It is exposed in three places in a length of 150 feet. At the easternmost exposure the vein is less than 2 inches wide and appears to end. At the westernmost exposure the vein is 5 feet wide and possibly, therefore, extends some distance farther, perhaps to join No. 3 vein.

Vein No. 7. Vein No. 7 is exposed at two places in a length of 150 feet and where visible has a width of 3 feet. It appears to parallel the main vein No. 8 and presumably extends both east and west of its outcrops.

Vein No. 8. Vein No. 8 is the vein on which the deep open-cut has been made and along which the 150-foot tunnel has been driven. The vein is exposed by the open-cut for a length of 360 feet and is exposed intermittently for a farther length of 290 feet. The eastern end of the vein is not exposed, but it presumably lies somewhere between the tunnel mouth and the east side of the gully into which the open-cut opens, for the vein almost certainly does not continue eastward across the gully. At the tunnel mouth the vein is about 15 feet wide, much of it is rich in apatite, but a zone about 5 feet thick is nearly pure magnetite. At the face of the tunnel, 150 feet in, the vein is fully 15 feet wide, but forward of the tunnel end in one place contracts or holds a horse of country rock. At the surface a 3-foot vein lies a few feet north of the main vein and underground the main vein appears to split and to be paralleled by another vein. The western part of the open-cut is wider than the eastern part and presumably the vein is wider in the west. About midway along the open-cut where it makes a right-angle turn, the vein has a width of 35 feet and as seen on the walls consists of band-like, comparatively pure masses of magnetite striking parallel with the vein and alternating with zones very rich in magnetite and with bands or horses of country rock. This point in the cut is about 140 feet above and nearly vertically over the tunnel face. Towards the west end of the cut, the floor is exposed and there towards the middle of the cut country rock is exposed for a width of 5 feet, with, on the north side, a vein of magnetite 5 feet wide and apparently increasing in width westward. On the south side of the rock parting is a wider vein which appears to narrow westward along the strike and owing to local decrease in the angle of dip gradually diverges from the north vein. At the west end of the open-cut there is a vertical rock face

about 20 feet high. The north, 5-foot vein continues to this point along the floor of the cut and extends upwards for 12 feet on the end rock face, but there abruptly ends and is succeeded upwards by a zone of much fractured rock. The south vein at the west end of the cut lies about 15 feet south of the north vein. Beyond the end of the cut the south vein is exposed in two places with widths of 3 to 4 feet and at a third place 290 feet west of the end of the cut it varies from 2 feet to an inch or so in width. Two hundred feet farther along the strike there are indications (vein No. 8 A) of a possible continuation of this vein.

The information gained along the open-cut and in the tunnel indicates, that as confirmed by imperfect evidence from other sources (a) the veins are very steeply inclined to the north, but are subject to local variations in the angle of dip and strike; (b) the veins fork and may end abruptly; and (c) much of the wider parts of the veins is very rich in apatite.

Vein No. 9. Vein No. 9 lies west of No. 8 vein, but not in line with it. No. 9 vein as indicated by a few outcrops is a single vein for a length of 140 feet, beyond which it splits into two diverging veins each traceable westward for a length of nearly 300 feet. The easternmost outcrop where the vein appears as a single body is 5 feet broad and presumably the vein continues eastward some considerable distance. A short distance south are exposed one or more thin veins presumably paralleling No. 9 vein, but not exposed elsewhere. At its next outcrop to the west, No. 9 vein is 15 feet wide and forks into two narrow diverging branches. The southern one outcrops for a length of 200 feet with a width at the end of the exposures of $3\frac{1}{2}$ feet. Thirty-five feet northerly is exposed the northern of the pair of branching veins and it is at least 5 feet wide. These two veins are not known to outcrop any farther westward and presumably rapidly die out in that direction.

Vein No. 10. Vein No. 10 lies north of veins Nos. 8 and 9 and is situated on the edge of a broad, exposureless area extending down and along the face of the hill. The vein is exposed at only one place and there has a width of 20 feet and a length of 50 feet, but only one-half the exposure is of pure magnetite, the remainder being largely apatite and fragments of rock. One hundred feet south of No. 10 vein, another vein, 2 feet wide, is exposed over a length of 10 feet.

Vein No. 11. Vein No. 11 is exposed at intervals over a length of 150 feet. It has a width of 2 feet. Fifty feet south of it is one exposure of a vein of about the same width.

Vein No. 12. Northward from the entrance to the tunnel on No. 8 vein, a number of exposures of narrow veins occur in a distance of 450 feet measured across their strike. The veins are not traceable for more than a few feet. The most southerly of these veins is exposed at intervals over a length of 60 feet, in places is 3 feet wide, but is not continuous along the strike. About 15 feet north of this vein is a single outcrop of a narrower, parallel vein. One hundred feet north, a one-foot vein outcrops at intervals over a length of 50 feet. One hundred feet farther north are three exposures of magnetite. One of these is a 2-foot vein dipping at a comparatively low angle; the second is a body 5 to 10 feet in diameter; and the third is of a vein several feet wide. One hundred and fifty feet farther north is a group of four exposures at each of which occur one or two veins a few inches or a foot wide.

Vein No. 13. Vein No. 13 occurs 250 feet north of group No. 12. Two veins outcrop, both of which are less than 2 feet in width.

Vein No. 14. Vein No. 14 occurs in the vicinity of an open-cut or quarry-like opening. One curving vein is traceable for a length of 150 feet. At its eastern end the vein is 5 feet thick and seems to end abruptly. Westward the vein increases in thickness and at the southeast corner of the open-cut has a width of 10 feet or more. This vein continues along the west wall of the opening where it is 12 feet thick and dips at an angle as low as 45 degrees, but in a distance of 25 feet along the strike it decreases in thickness and is represented by two or three narrow seams in a thickness of 5 feet of country rock. On the south face of the cut, beneath the seam-like vein, the country rock is cut by a number of veins of magnetite, the largest 1 foot thick. These veins for the most part parallel the main vein, but some follow other courses with irregular tongue-like projections and local swellings. On the east side of the cut, seams or veins of magnetite are exposed and one mass presents a triangular outline 10 feet broad at the base and rising 6 feet to the apex. In the general vicinity of this open-cut are a small number of other "showings" of magnetite, poorly exposed, and, seemingly, of irregular form.

Veins No. 15. Veins No. 15 are situated within 100 feet of the railway track and are represented by three outcrops. At the easternmost outcrop epidotized country rock is traversed by veinlets of magnetite. Along the strike of these veinlets, 100 feet to the west, an excavation has been made on a magnetite body which for a short distance along the strike appears to have been 10 or 15 feet wide, but which both to the east and west seems to give way to epidotized rock in part seamed with magnetite. One hundred feet west, an open-cut running southerly exposes a vein which on the floor of the cut is $2\frac{1}{2}$ feet wide, but which on a 20-foot vertical rock face gradually decreases in thickness to a mere film.

MODE OF ORIGIN

The magnetite bodies are all vein-like and follow curving east-west courses with local variations. The veins are essentially composed of magnetite, but in the larger ones apatite is locally very abundant in grains and larger forms characterizing zones up to several feet wide and following the walls of the veins or holding a median position. The apatite is nearly white, tinged green or pink, and has hitherto been referred to as feldspar. The individuals tend to have rounded, somewhat prismatic outlines and vary in size from microscopic up to an inch or more in length. Specks of magnetite appear to be embedded in some of the apatite crystals, but more generally the magnetite appears as a matrix to the apatite or as vein-like bands traversing the areas of nearly pure apatite. The walls of the veins are usually sharply defined, but occasionally angular fragments of country rock are present along one side of the vein. The country rock in the immediate vicinity of the veins and more particularly along their strike is, in many places, largely replaced by epidote.

The deposits in all respects behave as veins. They are not segregations of the diorite-monzonite country rock, though the veins and country rock may be of related origins.

ECONOMIC CONSIDERATIONS

The deposits occur as veins trending east and west and except locally dip at very high angles to the north. The veins are confined to a comparatively small area, over most of which rock is sufficiently well exposed to warrant concluding that no undetected large veins are present beneath the drift. The veins end suddenly. Most of them are too narrow to be of value. The wider veins may be observed to contract rather suddenly or to split into diverging veins too narrow to be of value.

Of the veins uncovered, four only are wide enough to be of value. Some of the narrower veins may widen with depth and wide veins may exist which do not extend to the present surface. There is a tendency for the wider veins to hold much apatite mainly confined to zones following one or both walls or occurring towards the middle of the vein. Number 8 vein, from which came most of the ore shipped in former years, appears to be the largest vein exposed. It had at the surface an average width of 10 to 15 feet over a length of about 400 feet and as indicated in the tunnel maintained its width through a vertical distance of more than 150 feet. A considerable part of the vein consists of apatite. From the surface to the level of the tunnel it is probable that there was once present about 65,000 tons of ore, the greater part of which still remains. There is nothing to indicate how deep the vein will maintain a thickness of 10 to 15 feet or more. The vein may terminate in depth as abruptly as it does at the surface.

In the case of No. 3 vein, as stated on a preceding page, the indications are such that it is estimated that there occurs at the bedrock surface a lenticular body of magnetite 120 feet long with a maximum diameter of 25 feet, and a second body 100 feet long with an average width of 7 or 8 feet. There is nothing to indicate how deep these bodies extend. If they continue for 100 feet, the amount of ore present would be only about 25,000 tons.

No. 10 vein is exposed at one place only, but there has a width of 20 feet, though much of the breadth is not true ore. It seems entirely probable that this vein extends for some considerable distance beneath the drift and that it maintains at least its surface width to a depth of 100 feet, but even so the available tonnage of ore could scarcely exceed 75,000 tons.

The total amount of available ore that may be expected to be present with some degree of certainty thus does not exceed 175,000 tons. If it be assumed that the wider parts of the three veins extend to depths as great as the lengths of these wider parts, the ore expected to be present would amount to about 325,000 tons.

(31 b) Magnet, Moose, Signal, and Anvil Mineral Claims

(*See* Figures 21-23)

LOCATION AND HISTORY

The Magnet, Moose, Signal, and Anvil mineral claims are situated about 7 miles west-southwest of Kamloops. They lie south of the road from Kamloops to Cherry creek, the northernmost claim being about one-half mile from a point on the highway distant 8 miles from Kamloops. The claims are the property of George McDonald and associates of Kamloops. The ore is magnetite and where best developed forms sharply defined veins of considerable size. The property has been held for a considerable number of years, but has not hitherto been referred to in governmental reports or technical journals.

The claims lie at an altitude of about 2,500 feet above sea-level or 1,400 feet above Kamloops lake and within an unforested tract stretching eastward for several miles from the valley of Cherry creek. This open country side is, in general, smoothly rolling with considerable areas devoid of rock exposures. Within the area of the claims, bedrock is largely concealed by drift and natural outcrops of ore seem to have been few and of limited size, but the claim owners have done considerable stripping and trenching and thereby have uncovered a number of mineralized occurrences. In addition to such work, several shallow trenches and an incline pit have been sunk on ore outcrops on the Moose claim and from these, some time ago, several hundred tons of ore were extracted and shipped. On the Magnet claim a shaft was sunk years ago in search of copper ore, but only magnetite was found. Both to the east and west of the claims, locations for copper ore have been made and one of these has been an active producer.

GENERAL GEOLOGY

The ore occurrences lie in the northern part of an area of plutonic rocks, which according to Dawson[1] commences at the Kamloops-Cherry Creek road and extends southeast for 10 miles with a width of 2 or 3 miles. A considerable portion of the northwestern part of this area is stated by Dawson to be occupied by "gabbros and dark diorites" similar to the rocks forming Cherry bluff on Kamloops lake, and which Dawson supposed to be of Tertiary age and perhaps to represent part of the volcanic vent through which the neighbouring Tertiary volcanic materials reached the surface. The area of these rocks bordering Kamloops lake has been restudied by Daly[2] who states that the plutonic rocks in question undoubtedly cut Triassic strata of the Nicola series, but that their relation to the Tertiary series is not so obvious. Because the plutonics are locally greatly sheared and much altered and whereas this is a condition rarely found to affect the Tertiary strata, Daly suggests that the plutonics are, "Triassic, representing a late phase in the eruptivity of that period. On this view the shearing of the intrusive and the deformation of the Tertiary rocks would be explained" by an early Tertiary movement. If the plutonic rocks are not of Tertiary age, it is not apparent why they should be classed as Triassic rather than late Jurassic, since in British Columbia the late Jurassic was a period of widely spread plutonic invasion.

The rocks of Cherry bluff are described by Daly as forming a heterogeneous mass varying from augite gabbro through augite diorite to monzonite. The rocks found on the mineral claims appear to be of the same types, are generally medium to fine-grained, and of a dark greenish or when fresh, dark grey shade. The rocks are feldspathic, many of the feldspars showing sharp crystal boundaries; the dark coloured constituents include pyroxene, biotite, and magnetite varying in relative proportions from place to place. In some phases the biotite forms large flakes filled with inclusions of the other rock constituents. The rocks are much fractured and weathered. Many have a pink tinge perhaps due to weathering and in places the pink tinge is very pronounced.

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[1] Dawson, G. M.: "Report on the Area of the Kamloops Map-sheet"; Geol. Surv., Canada, Ann. Rept., vol. VII, pt. B (1896). Accompanying map, Kamloops sheet, 1895.

[2] Daly, R. A.: Guide Book No. 8, Transcontinental Excursion C 1, pt. 2, pp. 232-233; Issued by the Geol. Surv., Canada, 1913.

"A Geological Reconnaissance between Golden and Kamloops, B.C., Along the Canadian Pacific Railway" Geol. Surv., Canada, Mem. 68, pp. 140-141 (1915).

DESCRIPTION OF ORE OCCURRENCES

Signal and Anvil Mineral Claims

On the Signal and Anvil claims (*See* Figure 21), the outcrops of magnetite are confined to an area about 300 feet broad and 1,000 feet long extending eastward from the head and along the east side of the bed of a small dry lake or pond. Bedrock outcrops in considerable volume over several limited patches along the south edge of this area, but elsewhere outcrops are lacking for a considerable distance in all directions. Within the area, the exposures for the most part are small and widely scattered, so that neither the full extent of the mineralization nor the direction of its trend is apparent, but judging from the relations holding on neighbouring claims, it is probable that a number of individual zones of mineralization are present, each striking about east and west and dipping at high angles.

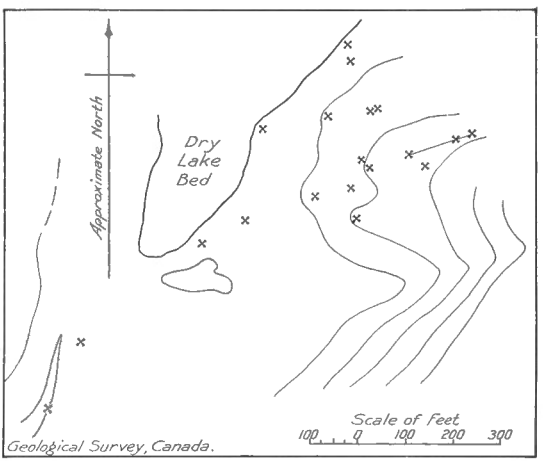

Figure 21. Magnetite occurrences, Signal and Anvil claims, Kamloops district, B.C. Magnetite outcrops are indicated by crosses or by crosses joined by a line. Contour interval, 20 feet.

The southwesternmost mineralized exposure (for position, *See* Figure 21) shows a few square feet of gabbro or monzonite holding thin, short, discontinuous seams of magnetite. The next mineralized occurrence lies 150 feet northward and consists of a small patch of loose fragments of nearly pure magnetite, possibly indicating the existence beneath them of a body of magnetite. No bedrock outcrops in the immediate vicinity. Three hundred and thirty feet to the northeast and close to the edge of the dry bed of the lake, on the west side of a knoll of country rock, is an irregular mass several feet in diameter in which pure magnetite forms small bodies so distributed as to appear to hold lens-shaped fragments of country rock 3 to 6 inches long.

One hundred feet northeast of the last-mentioned locality, a stripping 25 feet long by 5 feet wide shows magnetite in three distinct bodies. The magnetite is nearly pure, is compact, and occurs in the form of a fine-grained base holding larger grains, some of which show crystal outlines. One of the magnetite masses is 7 feet long with a maximum width of 3 feet; a

second has about the same length, but the width varies between 1 and 3 feet; the third is narrow and short. All three masses are rudely parallel with one another and sharply defined against the country rock.

About 175 feet nearly due east from the last-described exposure is a small outcrop, a few square feet in extent, in which magnetite occurs in grains and small aggregates distributed through a matrix of altered rock.

Eighty feet farther east is a group of three small exposures: one of barren country rock; one of country rock carrying a few seams of magnetite; and one showing a few masses of magnetite each several square feet in extent and accompanied by smaller bodies of nearly pure magnetite all lying in material impregnated with magnetite in grains and small formless aggregates. Fifty feet still farther east is a trench running in a northerly direction and exposing country rock for a length of 25 feet. In the southern half of this length are several zones largely of magnetite, the widest about 2 feet broad, and in the northern half are narrower, low-grade zones. One hundred feet farther east is the commencement of a shallow trench extending eastward for 150 feet. In this trench in several places is what appears like a breccia of country rock and masses of magnetite, the individual masses ranging in size from one foot in diameter down to such as are merely grains. Also, for the whole length of the trench, is a vein-like body of nearly pure magnetite, in places a foot wide, but swelling and pinching and not strictly continuous. The magnetite of this band is compact and fine-grained. To the south of the four occurrences just described, disseminated magnetite is visible in two places and farther south are large exposures of country rock showing no magnetite at all.

To the north, between the line of exposures just described and the shores of the dry lake bed, are five outcrops at which some magnetite is visible. At all these places magnetite occurs in grains and small aggregates, disseminated through gangue material, but not in amounts sufficient to constitute ore, though in several places there are small bodies, several feet in length, of nearly pure magnetite.

Moose Mineral Claim

The magnetite exposures of the Moose mineral claim and vicinity occur on the top of a hill near its steep north face and lie about 2,000 feet north-northeast of the Signal and Anvil claims. On the Moose claim, the magnetite in some places unmistakably forms sharply defined veins and presumably most of the occurrences are vein-like, striking in the western part of the area east-northeast, but changing farther east to a nearly due east course. All the veins may be of considerable length, perhaps many extend completely across the area mapped (*See* Figure 22), but the individual outcrops of magnetite and country rock are so few and so scattered that with a few exceptions any attempt to link up separate outcrops is not warranted and, therefore, the number of veins and their respective dimensions are unknown.

In the western part of the area, indications of the presence of five veins were noted. The southernmost of these outcrops in three places in a distance of 120 feet. At the most westerly exposure, the country rock is traversed by seamlets of magnetite; at the next exposure to the east, a width of 3 feet of magnetite is visible with only one wall exposed; at the easternmost outcrop, a strip of magnetite 1 foot wide and extending for 9 feet along the supposed line of strike has been uncovered. Magnetite

also outcrops at this last place at a point distant 8 feet across the strike from the main showing.

What is supposed to be a second magnetite vein is exposed at a spot 130 feet to the north of the first described vein. The outcrop of the second vein is 1 foot wide with both walls displayed. Four hundred feet eastward is a rock outcrop one side of which shows a small area seamed with magnetite and containing a mass of nearly pure magnetite one foot square. One hundred feet to the north of this are two exposures of magnetite probably belonging to a single vein or zone. The more easterly of these shows a body of nearly pure magnetite 15 feet long and 4½ feet broad, bounded on both sides by country rock seamed with magnetite. The

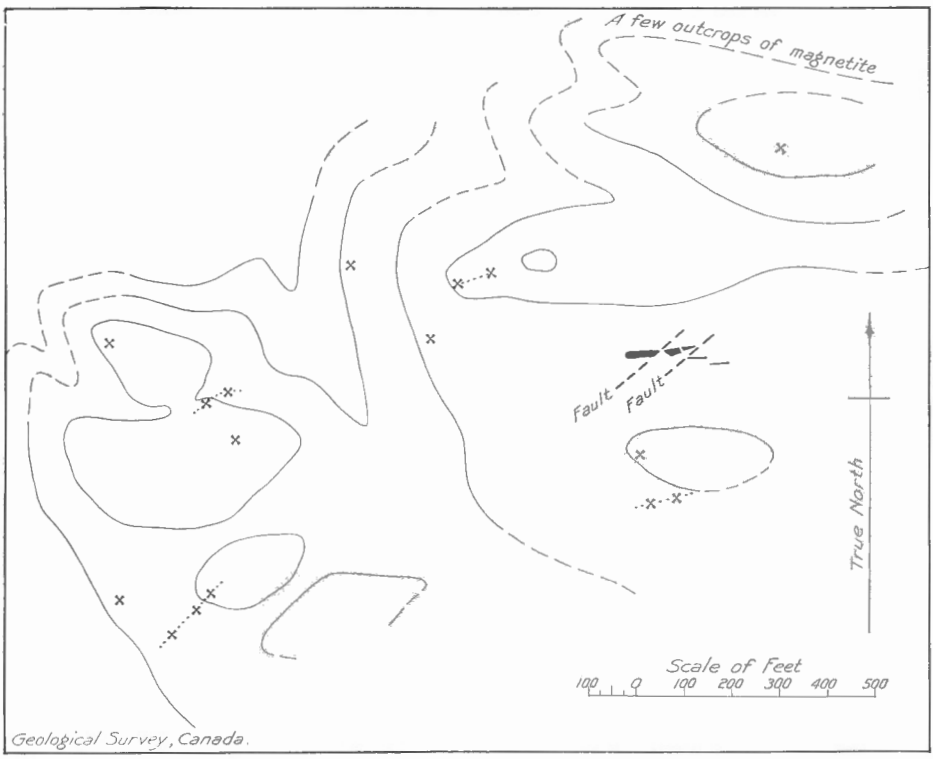

Figure 22. Magnetite occurrences, Moose claim, Kamloops district, B.C. Magnetite outcrops are indicated: (a) by crosses joined by dotted lines where they belong to a single vein; (b) by continuous lines where veins are exposed for more than a minimum length; (c) and by broad black bands where veins form a zone. Contour interval, 20 feet.

magnetite is finely granular, has the appearance of having been crushed, contains scattered, angular, pale yellowish individuals of apatite, some of large size, and is cut across the strike by a few sharply defined veins of white calcite one inch and less in width. Fifty feet to the west, what appears to be a continuation of the above-mentioned mass is exposed with a width of 2 feet, but the magnetite is not so pure as to the east. Two hundred feet to the north, two small areas each several feet square show some magnetite occurring breccia-like intermixed with country rock.

The above-described occurrences all lie on the western part of the property. To the east, across an exposureless hollow, another set of mineralized outcrops occur, some of which possibly are extensions of those just described. The southernmost of the second group consists of three isolated outcrops of magnetite distributed along a straight line over a distance of 75 feet. At each of these, the magnetite is nearly pure and forms vein-like bodies striking nearly due east and not less than 5 feet wide; their true width being unknown as only one wall is exposed. At one outcrop a strip of country rock lies within the body of iron ore. One hundred feet to the north, magnetite is exposed at intervals over a width of 12 feet.

The above-described occurrences lie on the southern slopes of a low ridge. In a shallow depression to the north and 200 feet away, are the most important showings on the property. These consist of several discontinuous trenches and a few strippings roughly in line with one another extending in an east and west direction. They reveal the presence of magnetite in considerable amount over a length of 250 feet. Beyond the limits of the artificial exposures, both across and along the direction of strike, exposures are wanting and there is nothing to indicate how far or under what conditions the magnetite bodies extend in these directions.

The most westerly exposures occur along a trench 60 feet long, 8 to 10 feet wide, and sunk a few feet in solid rock and ore. In the trench, nearly pure magnetite occurs in a series of sharply defined veins striking east and west and dipping to the south at angles differing very little from 45 degrees. The individual veins are separated from one another by country rock, much weathered and fractured and perhaps a little altered mineralogically. In all a thickness of about 20 feet of rock and vein matter is exposed. Along the south side of the cut, which in places is 8 feet deep, one vein of nearly pure magnetite seems to continue the whole distance (60 feet), with a thickness varying between 1 and 2 feet, the variable thickness being due to minor veins splitting away from and joining the main body. At one point in the small wall the following section is exposed, the uppermost body of magnetite being the seemingly continuous vein above referred to:

	Inches
Rock	
Magnetite	9
Rock	3
Magnetite	3
Rock	1½
Magnetite	6
Rock	2½
Magnetite	5
Rock	6
Magnetite	12 (base not exposed)

Along the strike some of the thinner veins die out and others gradually diverge from or approach one another. The lowest vein is partly concealed in the bottom of the trench, but seems to continue for some distance, gradually diverging from the uppermost vein, so that in a distance of 8 feet along the strike the intervening thickness increases from 27 inches to 40 inches and nearly all the thinner veins disappear, so that the upper and lower veins are separated by almost barren rock. Farther along the strike, towards the west end of the trench, the lower vein seems to split into a number of thin, diverging veins. Beneath the veins just described,

there are indications of the existence of two other larger veins, one of which at one point is at least 3 feet thick. Thus, in a thickness of some 20 feet, there appear to be four major veins, the uppermost of which is continuous the whole length of the trench, whereas the others possibly in some part of that distance die out or break up into groups of thin, diverging veins. The thickness and lateral extent of the three lower major veins is conjectural only, since they are but poorly exposed. At the east end of the trench, all the veins are terminated by a fault (*See* Figure 22).

A few feet to the east and a little north of the first trench, a second trench extends for about 20 feet to the east. In it much magnetite is visible, with the same general relations exhibited in the first trench, except that the dip of the veins is steeper. At the east end of this pit the following section is displayed:

	Inches
Rock	
Magnetite	19
Rock	6
Magnetite	2½
Rock	33½
Magnetite	45
Rock	19
Magnetite	8
Drift	

In a distance of 12 feet westward along the floor of the trench, the 19-inch and 45-inch veins of the above section increase in thickness and coalesce to form a solid mass of magnetite at least 8 feet thick with only one wall exposed. At the west end of the trench, 8 feet away, this body of magnetite has decreased to a thickness of 3 feet.

A third pit about 30 feet long extends eastward from just beyond the east end of the second pit. The third pit has largely caved in, so that any ore present is now largely obscured, but the general impression obtained was that the amount of ore present decreased eastwardly and that on the whole the pit was sunk in rock traversed by thin seams of magnetite occurring in a zone about 12 feet wide.

About 20 feet south of the third trench is a fourth trench, 40 feet long but narrow and shallow. A fifth trench lies to the west of, and slightly south of, the last mentioned. Magnetite occurs in both trenches. At the western end of the fourth trench a mass of ore, 5 feet thick, appears, but is abruptly ended towards the west by a fault. In the western part of the fifth trench, in places no ore is present, whereas approaching the east end, in a width of 10 feet, two veins of magnetite are visible, each 3 feet thick, but one of these splits into several thin veins.

It is possible that the veins visible in these different trenches all belong to one zone broken into short segments by faulting. Two such faults were noted (*See* Figure 22) and there is presumptive evidence of the existence of a third passing between the fourth and fifth trenches.

Four hundred feet west of the trenches is a small exposure of rock impregnated and seamed with magnetite. One hundred feet north of this, an inclined shaft or pit has been sunk to a depth of 30 feet. This excavation has been made along the hanging-wall side of a magnetite vein at least 1½ feet thick, striking slightly north of east and dipping south at an angle of 55 degrees. The same vein is exposed at a point 70 feet to the east. Two hundred and thirty feet west of the inclined pit an isolated exposure of magnetite, measuring about 2 square feet, is visible. Seven

hundred feet east-northeast of the inclined pit, a cutting exposes a body of magnetite 2 feet thick. This occurrence is on the summit of the hill on which the various described magnetite deposits occur. On the north side of this summit and part way down the north slope, are a few shallow trenches which, together with a few natural exposures, indicate the presence of several zones of magnetite veins striking east and west and dipping at high angles to the south. No vein thicker than one foot was observed. In places several veins occur within a space of several feet. These occurrences are distributed over a length of 600 feet east and west, and a breadth of 400 feet north and south.

Magnet Mineral Claim

The Magnet mineral claim lies about 1,500 feet west-northwest of the exposures on the Signal and Anvil claims. On the Magnet claim, rock outcrops are few and the magnetite occurrences are mostly revealed in shallow trenches and strippings. The number of mineral showings is not large, but they are so distributed and individually have such structures as to indicate that the various developments belong to distinct veins or zones, as represented on the accompanying Figure 23. Most of the veins follow curving courses striking east-southeast, but three veins or zones appear to strike towards the northeast; all are nearly vertical.

Vein No. 1 (*See* Figure 23) is represented by only one small outcrop which lies in the extreme western part of the field. Vein No. 2 is likewise represented by one outcrop only and this occurs 800 feet southeast of that of vein No. 1.

Vein No. 3 is represented by a series of outcrops distributed over a length of 1,300 feet. At the northwestern end of its exposed extent the vein is traceable by nearly continuous natural exposures for a distance of 300 feet up the general slope of the country side to the top of a small, low ridge. The vein is composed of nearly pure magnetite and nowhere is less than 10 feet wide, but its minimum width may be considerably more than this, for the walls of the body are not exposed. On the top of the low ridge referred to above, two outcrops within 50 feet of one another each indicates that there the vein is not less than 20 feet broad, but possibly the whole of this width is not ore. From the top of this local summit the vein is very imperfectly exposed for a distance of 500 feet eastward across a shallow hollow where ore is exposed at only three places spaced 100 feet or more apart. At the first of these outcrops, a width of 15 feet of ore is visible with only one wall exposed; at the second, only a foot or two of ore with some country rock projects through the drift; at the third, on the slope of a low ridge rising to the west, the vein is fully exposed and has a width of 19 feet, but encloses several, narrow, sheet-like bodies of country rock and at the edges the vein carries a considerable amount of apatite. On the top of the second rise, the vein is continuously exposed for 200 feet with a breadth ranging between 15 and 20 feet. The last exposure of this vein occurs 130 feet farther east where rock veined with magnetite is visible. This last outcrop possibly indicates that the vein is there approaching its end, or at least has markedly narrowed.

Vein No. 4 appears roughly to parallel No. 3 vein and lies north of it at distances varying between 50 and 100 feet. Towards the northwest, this vein is represented by two small outcrops of magnetite 70 feet apart. Northeasterly from this point, no outcrops occur for 600 feet and the

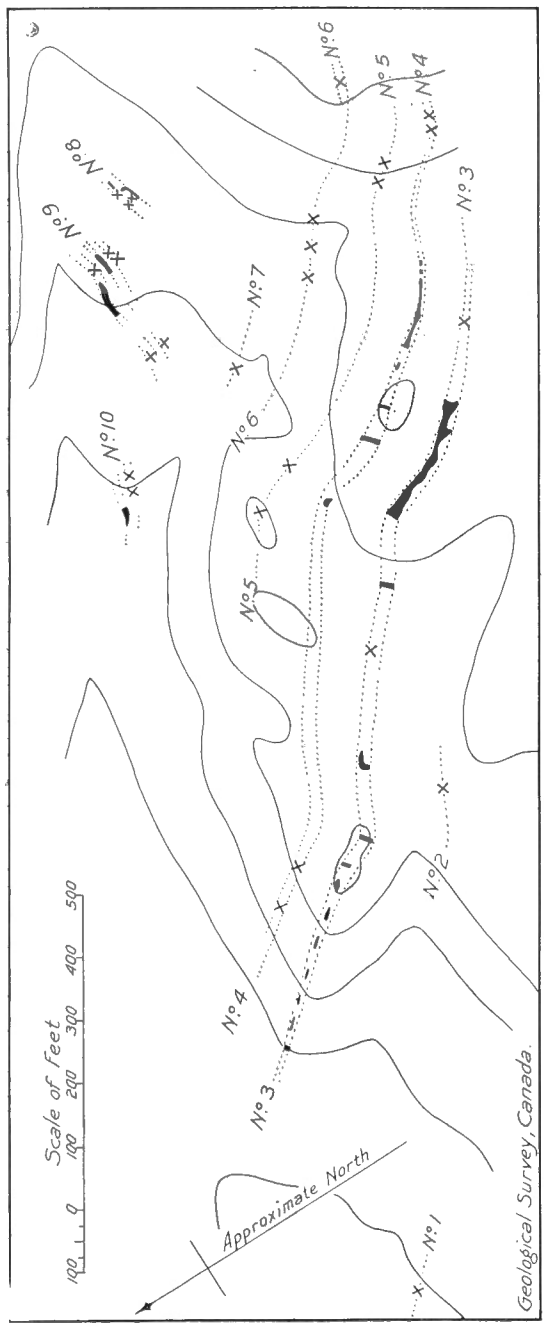

Figure 23. Magnetite occurrences, Magnet claim, Kamloops district, B.C. Exposures of magnetite shown in solid black and crosses, and hypothetical continuations of boundaries of veins in dotted lines. Veins are numbered as in text. Contour interval, 20 feet.

assumption that the two outcrops already described, and those yet to be described, belong to the same vein is only indirectly indicated by the disposition of the various outcrops of this and other veins and the regularity of the development of the veins where well exposed. On this assumption, No. 4 vein has a known length of 1,400 feet. The first outcrops after the 600-foot exposureless interval occur on the rise to the second ridge where several feet of ore is visible with only one wall exposed. On top of the ridge, 120 feet farther east, the vein is exposed with a width of 30 feet with both walls showing. From this point exposures are nearly continuous for a length of 300 feet and in a distance of 60 feet the breadth decreases from 30 to 20 feet whereas beyond this it gradually diminishes until at the end of the stretch of continuous exposures it is less than 8 feet. In this space, the vein at various places includes long sheets of country rock and the quality of the ore is further decreased by the presence of zones rich in apatite, the zones and the included ribs of country rock being disposed parallel with the gently curving walls of the vein. Beyond the stretch of continuous exposures, outcrops are lacking for a distance of 200 feet eastward, to where on the lower slopes of a gently rising hill ore is again exposed in several narrow masses over a length of 30 feet. There are no indications at this place that the vein is ending and it may continue for a long distance, but in the direction of the strike outcrops are wholly wanting.

Vein No. 5 lies north of No. 4 and parallels it at a distance varying between 50 and 80 feet. This vein is represented by two groups of exposures separated from one another by a concealed interval of 500 feet. It is quite possible that the two sets of exposures do not belong to one vein, but if they do the vein is at least 600 feet long and may be much longer; for in both directions along the strike, exposures are wanting. Only 1 or 2 feet of ore is visible at any of the exposures and it is possible that the vein is narrow throughout its extent.

Vein No. 6 lies 75 to 100 feet north of, and roughly parallel with, No. 5 vein. It is exposed at two places separated by an exposureless interval of 275 feet. At the western exposures the vein is visible at two points 60 feet apart and varies in width between 2 and 5 feet; at the eastern exposure ore shows for a width of 15 feet with only one wall uncovered. It seems reasonable to suppose that this vein, like the others, extends both east and west beyond the last visible outcrops, but in both directions exposures are entirely wanting over a large area.

Vein No. 7 lies north of vein No. 6 and is exposed at one place only, situated some 70 feet north of the assumed western prolongation of No. 6 vein. At the single outcrop of No. 7 vein, magnetite is exposed for a breadth of $1\frac{1}{2}$ feet and a length of 6 feet with only one wall visible.

Veins Nos. 8, 9, and 10 lie north of vein No. 7 and apparently belong to a group of veins following courses more irregular than those of the veins so far described. The outcrops occur in a wide, drift-covered hollow running eastward and it may be that the veins extend east along this hollow, as seems indicated by the disposition of the more easterly of the outcrops which suggest the existence of a vein system striking eastward along a direction nearly at right angles to the general course of the veins already described. If the outcrops of the second group are each considered to indicate distinct groups of veins, then, if they extend only a short distance westerly, their courses would cross or join the paths of the first-described veins which strike east-southeast (*See* Figure 23). The disposition of the

ore outcrops and of the few exposures of country rock, and the known variable behaviour of individual veins, are such that any one of a number of possible explanations of the structure might be correct and speculation seems valueless.

The exposures of No. 8 vein lie 300 feet east of No. 7 vein and seem to indicate the existence of a body striking directly towards No. 7 vein. The outcrops have been revealed by narrow, shallow trenches, consist of magnetite only, and lie within an area 50 feet long by 20 feet broad. No country rock is visible in the immediate neighbourhood. It is assumed that the ore-bodies or ore-body strikes parallel with the adjacent bodies of No. 9 vein and, therefore, its course is assumed to be northeast. No outcrops of rock or ore occur for a long distance in either direction along the supposed strike of No. 8 vein.

The outcrops of No. 9 vein or zone lie 100 feet northwest of the outcrops of No. 8 vein and seem to be composed of at least three parallel veins striking towards the northeast. The only outcrops are those revealed by a series of narrow, shallow trenches. On the east side two outcrops of magnetite occur in a space 5 feet wide and 20 feet long. These are assumed to belong to a single vein not less than 5 feet and possibly 10 feet wide. Ten feet northeast, a body of magnetite is visible over a length of 30 feet and a breadth of 5 feet, with country rock showing in places along the northwest side. These exposures are assumed to belong to a second vein at least 5 feet wide, striking northeast and perhaps again revealed 150 feet to the southwest where a shallow trench shows ore bounded on the west by country rock. At the No. 9 locality, a third body of ore shows to the west. It has an exposed length of 65 feet and a breadth of 10 feet. At one point country rock occurs along the eastern side. This mass is supposed to belong to a third vein, 10 feet or more wide and separated from the second vein by 12 to 15 feet of rock. Eighty feet to the southwest, an exposure along the assumed direction of the third vein shows ore having a breadth of at least 15 feet. The ore of these various occurrences is nearly pure magnetite, but locally carries considerable apatite.

The outcrops of No. 10 vein lie 300 feet west of those of No. 9 and seem to indicate the presence of two parallel veins striking nearly east and west and separated from one another by 5 to 10 feet of rock. The more northerly vein is exposed for a length of 35 feet with a width decreasing from 10 feet to less than 5 feet. The second vein is uncovered for a length of 35 feet, with a maximum width of 10 feet, decreasing westward to less than 5 feet.

MODE OF ORIGIN

The greater part of the exposures of magnetite on these claims distinctly belong to veins following gently curving courses which, with few exceptions, run approximately east and west. The veins are essentially composed of magnetite, but locally contain apatite in angular fragments disposed along zones paralleling the walls of the veins. In many places the walls of the veins are sharply defined and the bounding country rock shows little or no evidence of having been materially affected by the invading mineral solutions. At some places the adjoining country rock has been penetrated by seams of magnetite. The veins in places hold long masses of country rock apparently split off from the walls and in places show a marked tendency to split up into a number of relatively small

bodies. The veins apparently tend individually to extend for distances measurable in hundreds of yards. Along their courses they locally may expand to several times their breadth elsewhere and they may hold this increased breadth for hundreds of feet.

In addition to the vein-like bodies of magnetite, the mineral also occurs in small areas of a few square feet consisting of country rock traversed by seams of magnetite and in some cases accompanied by masses of magnetite ranging in size up to such as measure several feet or more in breadth and length. In some instances the country rock of these small areas has been altered so greatly that few of the original constituents remain. The exposures of these impregnations are small and isolated; their relations to the veins was not directly established, but it seems entirely probable that they and the veins were formed contemporaneously.

The parallelism displayed by the veins of each local area and their westerly course in general, all of which is again exemplified 6 miles to the west at Cherry bluff, indicate that the planes of weakness along which the veins have appeared have been produced by an agent acting in a uniform manner and over a considerable area, that is, presumably have been produced as the result of the adjustment of regional stresses.

The veins have developed in a plutonic rock of monzonitic aspect. Similar veins occur in similar rock at Cherry bluff 6 miles away and reliable information indicates that analogous magnetite veins occur to the southeast where similar or related plutonics have been recorded as being present. If the magnetite veins are confined to the gabbroic rocks, it may be that this association is merely due to the fact that these plutonic rocks under the action of earth forces yielded the necessary channels and sites for the magnetite solutions. On the other hand, the apparent close association of the magnetite veins with these plutonic rocks may also mean that the rocks and the vein-forming materials are related in origin.

ECONOMIC CONSIDERATIONS

The magnetite deposits occur as veins of magnetite with a variable amount of apatite locally developed in them. In addition there are also, as on the Signal and Anvil claims, small outcrops showing magnetite in streaks and veinlets or as grains and aggregates, disseminated through the country rock or through much altered material. The veins developed along parting planes which either before or during the period of filling widened, so that the net result was as if the magnetite had filled pre-existing open fissures. The places where the magnetite does not occur in sharply defined veins, but as veinlets or impregnations, may represent mineralized areas that vertically or laterally grade into one or more magnetite veins, but the general impression obtained was that the wider and more regular magnetite veins are not directly associated with bodies of disseminated magnetite. On the other hand since individual exposures of magnetite impregnations seem to trend parallel with the general east and west direction of the true veins and since in the western part of the area of the Moose claim, isolated exposures of magnetite impregnated material lie along the prolongation of the strike of normal veins, it seems possible that some of the impregnations do laterally or vertically grade into normal veins and the impregnations may be valuable indicators of the existence somewhere along the strike or dip of relatively wide and persistent magnetite veins.

Magnetite veins of any considerable size, now exposed, are confined to the eastern part of the Moose claim and to the Magnet claim. The individual veins, as seen on these claims and at Glen Iron mine at Cherry bluff where conditions are essentially similar, have certain plainly developed characteristics that have a marked bearing on their economic value. Most of the veins follow courses whose directions approximate east and west. The courses of individual veins are curving and neighbouring veins are roughly parallel with one another. Most of the veins are vertical or highly inclined, but some dip at angles as low as 45 degrees. The veins do not continue indefinitely either vertically or horizontally and examples were noted of veins terminating by gradually thinning and dying out both in an horizontal direction and in a vertical direction; in other cases veins were observed to split up into two or more veins which diverged from one another and in some cases at least, died away in a comparatively short distance. Some veins were observed to be comparatively wide over a relatively long distance, others for only a comparatively small part of their observed course; other veins, so far as they were now visible, maintained throughout a relatively narrow width. It is inferred that in general the notably wide part of any vein is a local development of comparatively limited extent. In wide veins parts of them were in nearly every case characterized by the occurrence of apatite in considerable volumes, sufficient to lower the grade of the ore in a marked degree. In other cases the wide parts of veins in places carried sheet-like horses of country rock whose presence would greatly reduce the amount of minable ore.

On the Signal and Anvil claims no magnetite ore of commercial value is exposed and it is thought to be improbable that any such ore occurs in the immediate vicinity of the magnetite-bearing outcrops now visible.

On the Moose claim and in that vicinity, several zones of veins 1 to 2 feet broad are exposed at a few places on the unmapped north brow of the hill on which the claim is staked. These veins appear to be individually too narrow to be of value and are not closely enough spaced to permit of mining several together. They are valuable as indicating that on the Moose property conditions are such that the veins may have a considerable lateral extent. To the south of the open-cuts on this claim, two isolated outcrops not belonging to the same vein show respectively widths of 5 feet or more and 12 feet or more. These exposures may indicate the presence of several veins each 5 feet or more wide, but nothing is known regarding their possible length nor as to whether they maintain their width along the strike where the whole country side is wanting in rock exposures of any kind. In the trenches just north of these two occurrences, much magnetite is visible over a length of 200 feet, but the iron ore occurs in a zone of veins which individually thin and thicken or die away. In places several veins may coalesce and jointly expand to a thickness much greater than their combined individual thicknesses, but these expanded parts have no great length and presumably no great depth. On the other hand, either along the strike where the ground is now all drift-covered, or at some depth, some of the individually thin veins might coalesce to form a vein comparatively broad and holding its breadth for a considerable distance. The amount of ore visible in these trenches is considerable; it may be equivalent to as much as 10 feet disposed in a number of roughly parallel veins contained in a thickness of 20 feet. An iron ore-body

of these characters and dimensions doutless could be mined at a profit if a not too distant market were available.

On the Magnet claim the amount of ore seems large. Outcrops belonging to what is thought to be one continuous vein, No. 3, occur over a length of 1,300 feet and so far as can be now determined its width over this total distance is nowhere less than 10 feet and over considerable stretches is between 15 and 20 feet. In places the amount of ore is reduced by a variable amount due to "horses" of country rock and to zones of ore intermixed with a large proportion of apatite. Further cross-trenching is needed to establish the average size and character of the vein, but at present it seems justifiable to assume that for a length of not less than 1,000 feet the vein will hold a minable width of 10 feet of ore. The depth to which the vein extends cannot be foretold, but considering the visible length, neither end having been uncovered, and its comparatively broad width, it seems reasonably certain that the vein will persist to a depth of at least several hundred feet, with the same average width as displayed on the surface; it might descend to much greater depths. It is estimated that No. 3 vein will maintain its minimum breadth for, on an average, a depth of 150 to 200 feet and be capable of furnishing not less than 200,000 tons of magnetite.

No. 4 vein is thought to outcrop for as great a distance as No. 3 vein, but has a proved width of 10 feet or over for a length of only 250 feet. In this distance the average breadth, making due allowances for inclusions of country rock and zones of apatite, is not less than 15 feet, the minimum minable contents of this part of the vein can scarcely be less than 50,000 tons, and it is possible that a comparatively small amount of cross-trenching would indicate that this vein is comparable in width and length with No. 3 vein.

Nos. 1, 5, 6, and 7 veins each outcrop at only one or two places and do not give any certain indications of being long or of width sufficient to warrant mining, but these veins comparatively speaking are unexplored and it is possible that systematic cross-trenching might bring to light extensions of the known parts of these veins in which the ore was of considerable width. It also is possible that at moderate depth one or more of these veins might expand considerably.

Nos. 8, 9, and 10 veins have each been uncovered at only a single spot and although in each case a very considerable breadth of ore has been brought to light, there is not sufficient information available to permit of making any reliable estimate of the value of these three veins or groups of veins. Further cross-trenching would be required to determine if these veins persist along the strike and their individual behaviour. Since these three groups of veins seem to have an abnormal strike, it is possible that the veins are also abnormal, may not continue far, and may possess very variable widths. The veins were not sampled for the purposes of this report, but the following assays of samples from the Magnet claim were made by the Department of Mines, Victoria, the first sample being reported as representing a width of 18 feet on a single vein.

Iron	50·7	55·2	49·5	53·0	49·4
Insoluble	10·4	3·7	15·1	8·0	12·6
Sulphur	trace	trace	.....	.....	.....
Phosphorus	1·6	3·0	.....	.....	.....
Lime	2·5	3·3	.....	.....	.....

NICOLA MINING DIVISION

(32 a) Iron Mountain and Vicinity, near Merritt

Sources of Information. Dawson, G. M.: "Preliminary Report on the Physical and Geological Features of the Southern Portion of the Interior of British Columbia, 1877"; Geol. Surv., Canada, Rept. of Prog. 1877-78, p. 122 B.
Ann. Rept., Minister of Mines, B.C., 1896, p. 573.
Ells, R. W.: "Nicola Coal-basin"; Geol. Surv., Canada, Sum. Rept. 1904, p. 49.
Johnston, R. A. A.: "The Copper Claims of Aspen Grove and Aberdeen Camp, B.C."; Geol. Surv., Canada, Sum. Rept. 1904, p. 80.
Lindeman, E., and Bolton, L. L.: "Iron Ore Occurrences in Canada"; Mines Branch, Dept. of Mines, Canada, vol. 2, p. 24 (1917).

The contained description is drawn from above listed, earlier reports.

GENERAL DESCRIPTION

According to Dawson . . . . "In the southeastern angle formed by . . . . (Nicola and Coldwater rivers) Iron mountain . . . . forms a prominent object. The greater part . . . . (is) of much altered volcanic rocks . . . . (thought possible to be Tertiary rather than Triassic, but) the summit shows the remnants of a covering of volcanic rocks of much newer aspect. . . . Veins of specular iron ore traverse the summit. . . . . Several were seen of a few inches in thickness but . . . . (a vein reported to be several feet wide, was not found). The ore appears to be . . . . of good quality." . . .

At one time the mineral occurrence was staked for the iron ore and was held by a Vancouver company. Johnston writes that the strata are . . . . "traversed by veins of white quartz . . . . sometimes seen to carry trifling amounts of specular iron, chalcopyrite, and pyrite. . . . In no instance, however, were any of these minerals noted in any appreciable amount." Ells concurs in this estimate of the value of the occurrence and also states that . . . . "on the summit of the range northeast of Coutlee (i.e. north of Iron mountain and north of Nicola river), a small deposit of specular ore was opened several years ago, but found to be irregular and of but small extent. . . . . A small and irregular deposit was also seen on the north flank of the hill south of Coutlee." . . .

(32 b) Iron Queen and Iron King, South of Nicola Lake

Source of Information. Brewer, W. M.: Ann. Rept., Minister of Mines, B.C., 1915, p. 231.
Whittier, W. H.: "An Investigation of the Iron Ore Resources of the Northwest"; Univ. of Washington, Bureau of Industrial Research, Bull. No. 2, p. 75 (1917).

The contained account is derived from the account by Brewer.

GENERAL DESCRIPTION

This deposit of limonite lies several miles south of Nicola lake. According to Brewer, a gulch extends nearly through both claims. Its width is . . . . "some 300 or 400 feet, and, to a greater or less degree, a large proportion of the surface is covered with the ore. . . . A series of long trenches (have been dug) across the gulch, the longest . . . . fully 300 feet by about 3 feet deep and about the same width. In all of these trenches the iron ore is exposed on the sides and bottom. . . . The trenches . . . . crosscut the deposit . . . . and demonstrate that it has an approximate length of about 2,000 feet and a width from about 50 up to 200 feet." . . . In one open-cut, the limonite shows in a face 10 feet high and 15 feet long.

A reliable estimate of the probable or possible amount of limonite present cannot be made from the information available. If the deposit is continuous over a length of 2,000 feet and has an average width of 125 feet, it would contain several hundred thousand tons of limonite if its average depth were 15 feet, but no evidence has been presented that the dimensions of the deposit are as large as this and possibly the total contents are considerably less than 100,000 tons.

In the annual report for 1913 of the Minister of Mines, British Columbia, it is stated, page 220, that 2 miles southeast of Nicola there is . . . . " a group of iron claims, on which (occurs) a body of unknown extent, of hematite." Probably this note relates to the above-described occurrence of limonite.

SIMILKAMEEN MINING DIVISION

(33) Lodestone Mountain, Tulameen District

Lodestone mountain is 7 miles southwest of Tulameen. The following account has been derived from reports by C. Camsell.[1]

"The presence of magnetite in the rocks of Lodestone mountain has long been known. . . . Several mining claims were at one time staked on this ground for iron ore, but they have long since been abandoned without any work having been done on them. The rock in which the magnetite occurs is pyroxenitic (Jurassic age), which occupies a belt from 1 to 2 miles wide extending from Olivine mountain southward (for 8 miles) to Lodestone mountain and beyond that for an unknown distance, . . . Everywhere . . . . the pyroxenite carries some magnetite as an original constituent. . . . In certain places . . . . the quantity of magnetite increases to such an extent that the rock might be classed as an ore of iron. . . . At these places it occurs in short, irregular veins or in large bunches in the pryoxenite. . . . These bodies are not connected with any system of fractures and are not secondarily deposited, but are primary constituents of the rock. . . . Judging merely by what is naturally exposed and the irregularity of the distribution of the bodies in the exposures, they have little present commercial value."

(34 AND 35) GREENWOOD AND GRAND FORKS MINING DIVISIONS

The large, now exhausted, deposits of low-grade copper ore at Phoenix, near Greenwood, and elsewhere in the Boundary district[2] and at Franklin camp[3] are characterized by the presence of abundant magnetite or hematite or both and in some instances these minerals form large, comparatively pure bodies. The deposits are of the "contact-metamorphic" type and in many cases formed along the edges of bodies of limestone. Though these deposits have not been regarded as a source of ore, their occurrence suggests that possibly large bodies essentially composed of iron ore may occur in the region.

[1] Camsell, C.: "Tulameen District, B.C."; Geol. Surv., Canada, Sum. Rept. 1909, pp. 114-115.
"Geology and Mineral Deposits of the Tulameen District, B.C."; Geol. Surv., Canada, Mem. 26, p. 168 (1913).
[2] Brock, R. W.: Geol. Surv., Canada, Sum. Rept. 1902, pp. 103-122.
[3] LeRoy, O. E.: Geol. Surv., Canada, Mems. Nos. 19 and 21.
Drysdale C. W.: Geol. Surv., Canada, Mem. 56.

TRAIL CREEK MINING DIVISION

(36) Lord Roberts Group, near Birchbank

Source of Information. Langley, A. G.: Ann. Rept., Minister of Mines, B.C., 1920, p. 137.

GENERAL DESCRIPTION

The Lord Roberts group of mineral claims are on the divide between Murphy and Sullivan creeks, 4 miles from Birchbank. According to Langley "a number of open-cuts and several shallow shafts . . . . (expose) a body of magnetite, which varies in grade and apparently follows the . . . . contact between the Trail granodiorite and . . . . the Rossland volcanic group . . . . epidote, garnet, and hornblende (are present) . . . . The best ore is a bluish, massive magnetite and has a width in several open-cuts of from 4 to 8 feet. . . . Other phases . . . . include higher percentages of pyrites, pyrrhotite, and traces of chalcopyrite. . . . There is abundant evidence of mineralization over the small area exploited by the shallow surface workings". . . .

NELSON MINING DIVISION

(37) Near Beasley

Information has been received that a body of magnetite occurs near Beasley, within a mile of the railway, on claims owned by W. Moore of Nelson. Very large masses of magnetite, not in place, were noted by Dawson[1] on the north bank of Kootenay river below the second fall. It is possible that these two occurrences of magnetite, as well as that on the Lord Roberts group of claims (*See* page 131), are replacement deposits of the "contact-metamorphic" type and have formed at or close to the edge of bodies of the Mesozoic granites, such as are so widely displayed through Kootenay district.

(38) Pend d'Oreille and Salmon Rivers

In the thick assemblage of sedimentary strata found near the International Boundary west from Kootenay Lake valley, Daly[2] found . . . "a deposit of magnetic iron ore aggregating 8 feet in thickness, though interrupted by small lenses of quartzite, ... (in) the ridge overlooking the South fork of the Salmon river just north of the boundary line. The deposit is interbedded with the slates and quartzites in the upper part of the great stratified series forming the main mountain range. The bed is noteworthy because of the apparent purity of the ore. . . . It was found in its proper place in the stratigraphic series, though with greatly reduced thickness . . . . on the ridge north of Lost creek . . . . 7 miles north". . . .

Hematite has been found on Pend d'Oreille river near its junction with Salmon river. According to Galloway[3] the country rock is limestone and the chief ore exposures are on Boundary creek. . . . "The main working is a tunnel 25 feet long, which apparently cuts . . . . a small body of iron ore . . . . 50 feet (wide but which) does not con-

[1] Dawson, G. M.: "Report on a Portion of the West Kootanie District, British Columbia"; Geol. Surv., Canada, Ann. Rept., vol. IV, pp. 65-66 (1891).
[2] Daly, R. A.: Geol. Surv., Canada, Sum. Rept. 1903, p. 100.
[3] Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1915, p. 167.

tinue for any distance along the strike, as another tunnel 100 feet to the north . . . . fails to show any iron. . . . Other smaller amounts of iron ore are exposed . . . . in different places. These . . . . (are) of the nature of iron cappings . . . . and have probably formed by the oxidation of . . . . sulphide". . . .

(39) Near Crawford Bay

Hematite, in some respects at least, behaving as a sedimentary deposit, has been found associated with conglomerate on Grays creek and the divide between Grays and Crawford creeks.

(40) Kitchener Iron Ore Deposits

(*See* Figure 24)

LOCATION

The principal iron ore deposits occur on Iron Range mountain west of Kitchener and north of Goat river. Iron ore occurs also south of Goat river, towards the head of Thompson creek. Other occurrences are reported to exist north of Iron Range mountain and, also, south of the head of Thompson creek on the west slopes of the Moyie range about the headwaters of Russell creek and Little Moyie river.

Iron Range mountain is a steep-sided ridge whose narrow summit is 6 miles long, stretches nearly due north and south, and rises 3,000 to 4,000 feet above Goat river to a general elevation of 6,000 feet above sea-level. The ridge is bounded by deep valleys, that of Bon Ton creek, an easterly flowing tributary of Goat river, on the north; Goat river on the east and south; and Arrow creek, another tributary of Goat river, on the west. A trail leaving the highway at a lumber mill a mile west of Kitchener climbs the southern face of the mountain and follows the ridge top to its northern end. A branch from a second trail running northward up Goat River valley rises on the eastern slopes of the mountain and joins the first-mentioned trail about midway along the summit of the ridge.

Thompson creek, a second ore-bearing locality, enters Goat river from the south, 3 miles west of Kitchener. It is a small, short stream in a steep draw in the mountain-side. A trail to the ore occurrences leaves the highway at the stream crossing and follows up along the waterway.

The ore at all the localities is hematite and outcrops along a nearly due north and south course, firstly at intervals over a distance of 6 miles along the summit of Iron Range mountain and, secondly, at the head of Thompson creek, about 3 miles south of the highway. The other reported occurrences north of Iron Range mountain, and south from the head of Thompson creek, lie on the same general north and south course.

HISTORY

The ore occurrences on Iron Range mountain were located by Mr. C. P. Hill, now of Victoria, B.C., in 1897 and succeeding years at a time when, due to the discoveries made at Rossland, ferruginous outcrops throughout the region were being staked in the hope that they might prove to be weathered outcrops of gold-bearing copper deposits. In 1901, the true nature

of the ore outcrops having been recognized, Mr. Hill disposed of the major part of his holdings to a Montreal syndicate closely allied to the Canadian Pacific railway, which now controls the property and administers it through the Department of Natural Resources, Canadian Pacific railway, Calgary, Alberta. In the spring of 1902, forty-two or three of the claims were Crown-granted and of these, eleven were retained by Mr. Hill. Up to this time several short tunnels and shallow shafts and a number of trenches had been opened and a diamond-drill hole driven a short distance. Since then little or no prospecting or development work has been undertaken until quite recently when a few shallow trenches were dug in the drift in search of possible extensions of ore-bearing zones.

The Crown-granted claims form a continuous strip, for the most part a single claim wide, and extend continuously for $7\frac{1}{2}$ miles from the north slope of Iron Range mountain, southward along the summit and down the south face nearly to Goat river at a place opposite the mouth of Thompson creek. At various times other claims have been staked alongside of those Crown-granted and in 1922 a number of those held by Mr. C. P. Hill were being surveyed preparatory to obtaining Crown-grants of the same.

Discoveries of iron ore are reported to have been made on the Bon Ton Creek valley slopes facing the north end of Iron Range mountain, but no definite information was obtained regarding these alleged discoveries. The outcrops of iron ore on Thompson creek, south of Goat river, were found some years ago and led to the staking of two groups of claims, one known as the Great War group owned by the British Columbia Iron Company, and the other known as the Iron Mask group owned by R. Lamont and associates of Creston, B.C. A few trenches have been dug on some of these properties. The claims are not known to have been Crown-granted. Claims also have been staked on the southward continuation of the ore-bearing belt on the upper western slopes of the Moyie range and in 1922 a slight amount of prospecting work was done there.

Published accounts of the ore occurrences are few in number and the following list is believed to be complete.

Ann. Rept., Minister of Mines, B.C., 1901, pp. 1,033-1,034. This notice consists mainly of a statement by W. Blakemore prepared by him when engaged in prospecting the properties on Iron Range mountain.

Blakemore, W.: "The Iron Ore Deposits Near Kitchener, B.C."; Jour. Can. Min. Inst., vol. 5, pp. 76-80 (1902).

Ann. Rept., Minister of Mines, B.C., 1902, p. 163. A brief note regarding the development work being done on Iron Range mountain and the alleged discovery of another iron ore occurrence farther north.

Sloan, W. P.: "The Goat River Mining Division"; B.C. Min. Rec., vol. 10, pp. 482-485 (Feb. 1903). Reports discovery of ore north of the claims on Iron Range mountain.

Lindeman, E., and Bolton, L. L.: "Iron Ore Occurrences in Canada"; Mines Branch, Dept. of Mines, Canada, vol. 2, p. 25 (1917). A brief statement based on earlier accounts.

Langley, A. G.: "Eastern District (No. 5)"; Ann. Rept., Minister of Mines, B.C., 1919, pp. 137-138. A description of the ore occurrences south of Goat river, on Thompson creek.

Allan, J. A.: First Ann. Rept. on the Mineral Resources of Alberta; Edmonton, 1920, pp. 68-69. A brief generalized description based on information supplied by owners of the properties.

Langley, A. G.: "Eastern District (No. 5)"; Ann. Rept., Minister of Mines, B.C., 1921, pp. 145-149. A description of the Iron Range deposits.

Schofield, S. J.: "The Ore Deposits of British Columbia"; Trans. Can. Inst. Min. and Met., vol. 24, pp. 86-98 (1921). The mode of origin of the Kitchener deposits is discussed.

GENERAL GEOLOGY

The strata of Iron Range mountain and vicinity belong to the Precambrian Aldridge formation[1] composed of greenish grey, dense, argillaceous quartzites and coarser but still fine-grained, less argillaceous quartzites. Intrusive in these measures are sills and dykes of dark green, basic igneous rocks. The argillaceous quartzites commonly show no signs of bedding, usually have a schistose parting, and occur both in thick, homogeneous zones and in narrower zones and beds interstratified with the coarser, purer quartzites, which in many places are distinctly bedded. At the north end of Iron Range mountain the beds dip westward at angles varying between 20 degrees and 60 degrees and averaging 40 degrees. Southward along the ridge the direction of the dip remains westerly, but the value of the angle decreases and at the south end the strata in places are nearly horizontal, as though lying on the axis of a broad, anticlinal fold striking northwestward. Along the south face of the mountain the beds dip to the west and the angle of dip increases westward. Everywhere the direction and value of the dip show local variations which in places, and perhaps everywhere, are due to the presence of minor flexures. No direct evidence was observed of the existence of faults.

The intrusive igneous rocks very clearly occur both as sills and as dykes. The dykes, so far as observed, are vertical or nearly so and none is more than a few yards wide. The sills are sheet-like bodies whose attitude approximately conforms to that of the enclosing sediments. The individual sills vary widely in thickness, Some are only a few feet thick, others appear to be more than 100 feet thick. On the summit of Iron Range mountain examples of both dykes and sills are to be seen and two exceptionally thick sills there outcrop. One of these, apparently at least 100 feet thick, is partly exposed in a series of outcrops crossing the ridge top in the vicinity of the transverse depression on the Maple Leaf claim about $1\frac{3}{4}$ miles south of the north end of the ridge summit. Since the general strike of the strata is approximately north and south and the series of igneous outcrops extends east and west, it might be imagined that the igneous body cuts across the sediments, either as a large dyke or some more irregularly shaped body. The mass, however, seems to be a thick sill, perhaps at this place splitting in two. The false appearance of being a crosscutting body is due to local variations in the direction and value of the dip of the enclosing strata and to the action of erosion which has removed part of the sedimentary cover and thus exposed the igneous body over an area extending across the direction of strike of the enclosing measures. The sill-like nature of the igneous mass is clearly indicated in a series of exposures on the east face of the ridge where north of the transverse depression the upper contact is visible and may be seen to be nearly but not quite parallel to the bedding planes of the overlying sediments. A second, presumably thicker, sill is imperfectly exposed farther south near the summit of the south face of the ridge in the vicinity of the Czar and Emperor claims. At this locality also, the manner of distribution of the outcrops of the igneous rock might be taken to indicate that the mass cuts across the strata, but it seems almost certain that it is a thick sill conforming in dip and strike with the enclosing sediments.

[1] Schofield, S. J.: Map 147A, Cranbrook, Kootenay District, British Columbia; Geol. Surv., Canada, 1915.

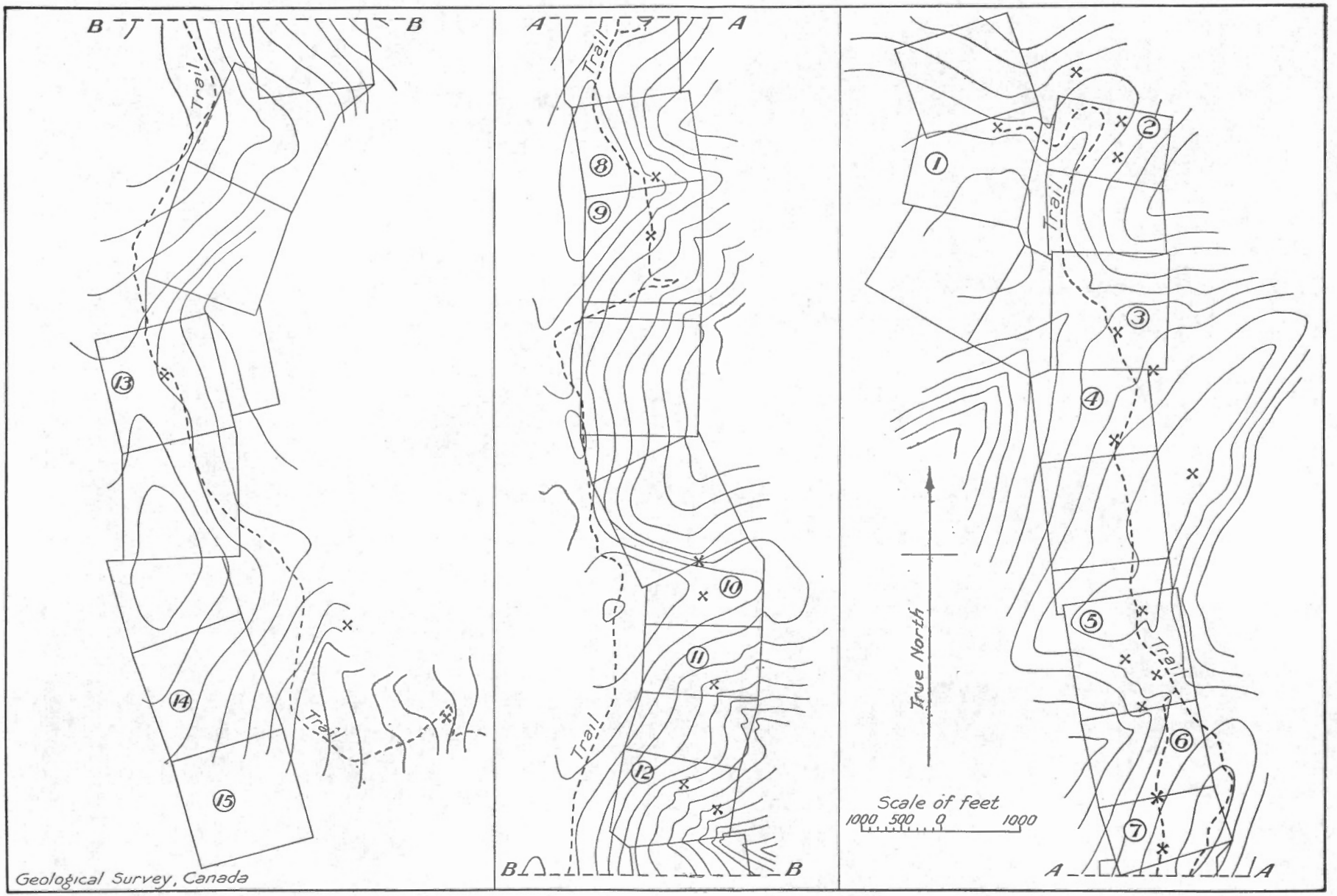

Figure 24. Hematite localities, Iron Range mountain, Kootenay district, B.C. Contour interval, 100 feet. Mineral localities are indicated by crosses. Mining claims referred to in text are indicated by numbers and are as follows: 1, Golden Cap; 2, Union Jack; 3, American Flag; 4, O-Ray; 5, Maple Leaf; 6, Keepsake; 7, Rhodesia; 8, La Grande; 9, Cracker Jack; 10, Dakota; 11, Idaho; 12, Pacific; 13, Rambler; 14, Emperor; 15, Czar.

DESCRIPTION OF ORE OCCURRENCES

The ore outcrops examined are confined to the summit of Iron Range mountain and the head of Thompson creek. They are, for the most part, artificial exposures made years ago and are separated from one another by drift-covered stretches. The exposures are usually limited in extent and none shows the full width of the mineralized rock. They consist of country rock impregnated with hematite and quartz in varying proportions and quantities. In places the hematite forms nearly pure bodies 4 to 20 feet thick, but of unknown length and depth. The hematite is usually compact, very fine-grained, minutely scaly, but in part, where it has been subjected to stresses, it is more micaceous and is traversed by closely spaced, lustrous, parting planes. A small amount of magnetite is present in some places. As a rule little or no pyrite or other sulphide is visible. The country rock is usually quartzite, but in places dykes of igneous rock are involved and in several localities the mineralization seems to have extended into the sills.

The individual ore outcrops have an irregular banded structure dipping vertically or at very high angles to the west and striking in a general way north and south. The banded structure where best developed is due to a succession of zones of varying widths and compositions. In some the material is largely country rock impregnated or seamed and filmed with hematite or quartz or both these minerals. Others are largely of hematite or of hematite and quartz. In the several instances where considerable breadths of wider mineralized areas are visible, the amount of mineralization is at a maximum close to one edge of the exposure and, on the whole, gradually decreases in amount in the direction of the other edge.

The ore outcrops on Iron Range mountain succeed one another within a strip of country 6 miles long and 1,800 feet broad. The structures of the individual exposures parallel the general trend of the whole series of outcrops and this and other phenomena have led various observers to assume that the isolated, mineralized outcrops belong to a few parallel zones each extending for a comparatively long distance and, in some cases, marked by an intermittent or perhaps continuous border of high-grade hematite ore. There is direct evidence that individual mineralized zones are as much as several hundred yards in length and possess fairly uniform characters over such lengths. But there is no evidence indicating whether the individual zones are few or many, are relatively long or short, or whether the bodies of relatively pure hematite are short or of considerable length.

The positions of the ore outcrops seen on Iron Range mountain are indicated on Figure 24; possibly other unnoted outcrops are present, but there is no reason to believe there are many such. The three most northerly outcrops lie at the north end of the ridge within a breadth of 300 yards across the strike. The most westerly showing is on the Golden Cup claim where a tunnel has been driven south-southwest for, judging from the size of the dump, 50 feet or more. Forming the east side of the entrance to the tunnel is a 12-foot rock face of dark igneous rock, presumably a dyke. This rock is seamed with narrow veins of quartz and veinlets of hematite and holds many minute crystals of magnetite in the immediate vicinity of the veins. West of the igneous body the strata appear to be altered quartzite bleached white and comparatively soft. It is veined, seamed, and impregnated with quartz and hematite in amounts diminishing

westward through the breadth of the 30-foot long artificial rock face. Near the tunnel a small amount of pyrite is visible. At the tunnel entrance, the mineralized zone in the quartzites is formed of small, angular fragments of country rock lying in a matrix of hematite and quartz. In places the matrix preponderates, in other places the rock fragments are in excess. The individual fragments are usually traversed by veinlets of hematite and quartz and in some cases the veinlets are so numerous that the rock fragments appear as an aggregate of grains separated from one another by films of hematite and quartz. A hand specimen will exhibit all gradations from solid, angular rock fragments an inch or so in diameter and separated from one another by narrow seams of hematite, to other fragments now resolved into minute pieces, and, finally, to areas of hematite several inches in diameter but carrying innumerable minute grains which seemingly represent remnants of a once solid and comparatively large rock fragment. Towards the west, the breccia-like appearance gradually dies away and at the west edge of the rock face the quartzite is compact and only sparingly traversed by minute, approximately vertical seams of hematite and of hematite and quartz. Nowhere in the rock face does the hematite constitute an ore-body and, judging from the materials on the dump, no body of ore was penetrated by the tunnel. The mineral-bearing zone appears to be nearly vertical and its strike is south-southwest judging by the occurrence of a small outcrop of similarly altered and impregnated rock visible 60 yards farther south and 80 feet higher up the slope.

On the Union Jack claim, on the east slope of the ridge, 300 yards east of the above-described exposure, are outcrops of another zone of igneous and sedimentary rocks seamed and impregnated with quartz and hematite. In this instance the zone is continously exposed over a length of 300 feet and at intervals for 300 feet farther. The strike is a little west of south and the dip appears to be at very high angles to the west. The exposures occur along the edge of a drift-covered area stretching eastward down the hill-side and both to the north and south, the outcrops disappear under soil. The width of the exposures varies and much of the outcrop consists essentially of silicified country rock traversed by quartz veins and seams of hematite. The greatest exposed width is 55 feet and at this point, commencing at the eastern drift boundary, the zone for a breadth of 10 feet consists of a dark igneous rock veined with quartz and hematite. For spaces of a foot or so, the igneous rock is fairly free from quartz or hematite, and alternating spaces are largely of vein quartz, or of hematite, or of a mixture of the two minerals. In the next 10 feet to the west, the igneous rock gives place to altered quartzite with several zones, 1 to 2 feet broad, largely of hematite veined with white quartz. The next 15 feet is of altered quartzite with zones heavily impregnated with hematite through which quartz occurs both in irregular veins and in disseminated grains. The remaining 20 feet along the west side of the exposure and presumably close to the west boundary of the zone is of altered quartzite cut by many quartz veins and with, here and there, thin seams of hematite. In general the amount of hematite decreases from east to west and nowhere is a body of hematite ore of any size exposed.

About midway between the outcrops on the Union Jack and Golden Cap claims several shallow trenches on the Jolly Boy claim reveal mineralized strata such as occur on the Union Jack location, but poorer in hematite contents.

Seven hundred and fifty yards southward along the strike of the mineralized zone exposed on the Union Jack claim, is a shaft, now full of water, sunk in hematite ore and situated on the American Flag claim at a point just east of the trail. Outcrops are practically limited to the margins of the shaft. The east boundary of the ore-body appears to be a dyke; towards the west side of the ore mass, vein quartz is abundant. Judging from the material on the dump, much first-class, compact, hematite ore was encountered in the shaft. Blakemore[1] describing this occurrence at the time the shaft was sunk, states that the ore zone was nearly 20 feet thick and that the thickness and quality remained constant to the bottom of the shaft. Langley[2] states that a sample taken across the 10 feet of hematite now exposed at the surface gave, on assaying, the following results:

	Per cent
Metallic iron	55
Sulphur	trace
Phosphorus	none
Silica	6·10

The body of ore at the shaft on the American Flag claims appears to strike in a southerly direction and to dip at a very high angle to the west. No other outcrops of rock or ore occur in the immediate vicinity and none for long distances in either direction along the line of strike.

Southeast of the shaft, 225 yards away, near the southeast corner of the American Flag claim, a shallow trench shows a few feet of altered quartzite seamed with hematite and holding at one place, much pyrite.

On the O-Ray claim 400 yards south of the American Flag shaft, another shaft, now full of water, has been sunk in hematite ore, as is indicated by the materials on the dump. Blakemore[3] states that the shaft is 50 feet deep and the ore-body nearly 20 feet thick. Langley[4] referring to this occurrence states that the shaft is 35 feet deep and that "at the bottom . . . . an 18-foot crosscut has been run from wall to wall. Across this width, a representative sample was taken which ran as follows: iron, 55·2 per cent; sulphur, nil; phosphorus, trace; silica, 7·9 per cent. The wall-rock exposed in either face of the crosscut was decomposed quartzite heavily impregnated with iron". . . .

The ore zone at the O-Ray shaft appears to strike in a southerly direction and to dip at a very high angle to the west. Seventy yards southward, a short trench on the west side of the trail discloses quartz-veined rock followed eastward by 6 feet of hematite bearing a little vein quartz. No other exposures either of rock or the mineralized zones occur in the immediate vicinity. To the east, on the east slope of the ridge top, 350 yards away, a shallow trench shows altered quartzite sparingly impregnated with hematite and vein quartz.

A series of exposures occur farther south on the Maple Leaf claim. East of the trail a shaft has been sunk at a point nearly 800 yards south of the O-Ray shaft. The material on the dump indicates that ore and an altered igneous rock were encountered. Blakemore[5] states that this shaft was sunk 50 feet on a "vein" of ore 6 feet wide.

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[1] Op. cit., Jour. Can. Min. Inst., vol. 5, p. 77.
[2] Op. cit., Ann. Rept., Minister of Mines, B.C., 1921, p. 147.
[3] Op. cit., p. 78.
[4] Op. cit., p. 147.
[5] Op. cit., p. 77.

In a draw 200 yards to the west of south from the Maple Leaf shaft, is a small trench showing several feet of hematite ore followed to the west by quartzite impregnated with much vein quartz. The few feet of ore carries much vein quartz in disseminated grains, holds small magnetite crystals and considerable pyrite. A short distance south of this occurrence, on the side of a second draw, are a number of outcrops which, commencing at the south boundary of the Maple Leaf claim, occur intermittently over a distance of 200 yards along a general northeasterly course. The more southerly of these exposures consist largely, almost solidly, of vein quartz in places showing to a width of 10 feet. In some places there is little or no hematite, in other places ore with a width of several feet is exposed. Farther northeast, the amount of vein quartz decreases and the exposures consist of altered rock, in part igneous, veined with quartz and impregnated with hematite.

Near the south boundary of the Keepsake claim, close to the trail, and 750 yards south of the Maple Leaf shaft, a small open-cut in drift shows at its rock face a body of hematite, 8 feet wide on the north side of the cutting and less than 4 feet wide on the south side only 10 feet away. A diamond-drill hole was driven here in 1901. It is reported to have followed the ore along the dip for a considerable depth. The ore consists of hematite with, here and there, small irregular bodies of quartz. Langley[1] states that a sample taken by him across the 8 feet of ore when assayed gave the following returns:

	Per cent
Metallic iron	46·00
Sulphur	none
Phosphorus	none
Silica	26·50

The ore is largely very dark grey, nearly black, hematite, partly very dense, partly in minute scales giving a brilliant lustre to a series of partings cutting one another at obtuse angles. The material exhibits occasional narrow quartz veinlets. There are all gradations from pure or nearly pure hematite to paler coloured material composed largely of minute grains of quartz in a hematite matrix. A characteristic feature, especially noticeable in the more siliceous parts, is the presence of innumerable cavities usually so small as to escape detection unless specially sought for. In places the cavities are so numerous as to give the ore a scoriaceous appearance.

East of the ore-body, the mineralized rock has been stripped for 42 feet across the strata. The first 15 feet have the appearance of a breccia composed of angular fragments of pinkish quartzite varying in size from such as are several inches in diameter down to minute specks. These fragments in amount greatly exceed the matrix which in part is of fine-grained hematite, in part is largely of minute quartz grains. All gradations occur from large, homogeneous quartzite fragments to areas of hematite impregnated with minute quartz grains. Many of the larger fragments are penetrated and crossed by seams of hematite. In places hematite is in excess of the quartzite and in such spots parts of the matrix may be nearly pure hematite, but such parts grade into more siliceous material holding specks and larger fragments of pink quartzite. In this breccia-like material, the remains of quartz veins are visible and this material seems to bear the same relations to the hematite as does the quartzite.

[1] Op. cit., p. 148.

The breccia-like material is bounded on the east by a 4-foot body of white vein quartz, beyond which for a distance of 23 feet to the drift boundary, the material is altered quartzite bearing films, veinlets, and veins of hematite, much of it very siliceous.

To the south, on the Rhodesia claim, close to the trail, two small trenches respectively 60 yards and 250 yards south of the Keepsake open-cut, reveal mineralized rock possibly lying in a southward extension of the same zone.

The next mineralized outcrops occur 800 yards farther south on the La Grande claim where a mineralized zone outcrops for a length of 250 feet with, in places, masses of siliceous hematite several feet thick. Three hundred yards farther south, on the Cracker Jack claim and in line with the mineralized zone on the La Grande claim, are several small exposures of quartzite impregnated with vein quartz and hematite, the latter in places forming seams several inches thick. On the Dakota claim, near the north boundary 1,400 yards southward of the Cracker Jack outcrops, a zone rich in quartz veins is visible and, on the same claim, 150 yards farther south, a small open-cut shows altered rock veined and impregnated with quartz and bearing films and seams of hematite. On the Idaho claim, 375 yards still farther south, a quartz-seamed zone carrying some hematite outcrops on the side of a draw and is exposed for a length of 100 feet along a north-south direction. On the Pacific claim, 450 yards southward, a short tunnel shows ore several feet wide and a little to the east on the same claim, hematite ore outcrops with a width of about 8 feet.

The next mineralized occurrence is 2,000 yards southward from those on the Pacific claim and is on the Agnes claim where a shaft close to the trail shows altered quartzite seamed with hematite. The most southerly known occurrences lie, respectively, 1,300 and 1,900 yards southeast of the Agnes shaft. The more northerly of these shows igneous rock impregnated with hematite. At the second occurrence, a narrow open-cut shows about 1 foot of hematite in siliceous rock.

The ore occurrences on Thompson creek were not visited, but M. E. Hurst, field assistant, reports that the ore is of the same general type as on Iron mountain, though iron pyrites was more noticeable. Langley[1] states that ore was visible in several trenches, but nowhere else, and that the hematite was accompanied by considerable magnetite.

MODE OF ORIGIN

In the earliest descriptions of the deposits on Iron Range mountain, Blakemore clearly indicated his belief that the ore occurred at a particular stratigraphic horizon in the sediments and near an igneous body. He did not, however, offer any explanation of the mode of origin. Recently, Schofield[2] has suggested that the ores are of sedimentary origin. Langley did not discuss the question of origin, though he drew attention to the frequent association of the ores with the igneous rocks. Others who have examined the properties are of the opinion that the ores are connected in origin with certain of the igneous bodies and suppose that these particular masses are neither sills nor dykes.

[1] Op. cit., Ann. Rept., Minister of Mines, B.C., 1919, pp. 137-138.
[2] Schofield, S. J.: Trans. Can. Inst. Min. and Met., vol. 24, p. 96 (1922).

The ore outcrops on Iron Range mountain occur within a comparatively narrow, band-like area 6 miles long and striking nearly north and south. At every mineralized outcrop the structure seems to be nearly vertical or to dip westward at angles of 75 degrees or higher, whereas the general strike of the strata is east of north and the dip is to the west at angles that decrease from an average value of 40 degrees in the north to 5 to 10 degrees in the south. It is certain, therefore, that the ore does not occur at a constant horizon and cannot be of sedimentary origin.

The general character and nearly vertical attitude of every mineralized occurrence, their general north-south strike, their occurrence so far as known only within a long, narrow, band-like area, and the fact that in several instances they form nearly continuous outcrops 200 yards long, are all features indicating that the ore outcrops belong to a system of mineralized zones, striking north and south, inclined at very high angles and, in a general way, vein-like in structure.

Both sedimentary and igneous rocks are involved in some of the mineralized areas, but in other instances only sedimentary rocks are evident. The introduction of the vein quartz and the hematite took place after the consolidation of the igneous rocks, for they are veined, impregnated, and partly replaced by these two minerals. All the igneous rocks certainly do not belong to one body, although all may be essentially contemporaneous and products of a single deep-seated source. It has been claimed by some who have examined the deposits on Iron Range mountain that the mineralization is due to the igneous bodies. But these bodies are not confined to the narrow strip within which the iron ores occur and, therefore, those observers who advocate a direct igneous origin for the ore, in searching for some feature peculiar to the long, band-like area of mineralization, have been led to infer that the two igneous areas outcropping respectively on the south brow of the ridge and several miles farther north in the vicinity of the Maple Leaf claim, belong to an extensive crosscutting body not of the nature of a dyke or a sill. As already stated in discussing the general geology of the locality, the present writer is of the opinion that the outcrops at these two localities belong to two or perhaps a single sill 100 feet or more thick. If, as is thought to be the case, the igneous rocks of the long band of mineralization are in no way peculiar to that band, then no reason remains for assuming that the igneous rocks directly gave rise to the mineralization. The igneous rocks and the mineralization may be distinct results from a common cause and the igneous bodies as structural features may have influenced the localization of the mineralization.

The invariable presence of both vein quartz and hematite in the mineralized zones indicates a common source for the two minerals, but primarily the hematite does not occur as a constituent of quartz veins, though in places sparingly present in them. The two minerals seem to have separately formed. Possibly some of the quartz appeared first, for instances were noted of the hematite penetrating and partly replacing vein quartz. The zonal structure characterizing various outcrops seems to indicate that the mineralization progressed in stages. The breccia-like material seen in several places does not appear to be a true breccia, for the individual fragments seem still to be in place relative to one another. The general structure is as if narrow, north-south zones of the rock had been greatly fractured and then invaded by solutions depositing hematite and quartz. In numerous instances it seemed also as if the hematite

had partly or wholly replaced the country rock. It is possible that the larger masses of nearly pure hematite formed in some such way.

In the foregoing discussion it has been assumed that the hematite is an original mineral. Save for the minutely scoriaceous character, the hematite gives no signs of having resulted from the alteration in place of some other mineral. Even this minutely porous texture may be only a surface character due to differential weathering.

ECONOMIC CONSIDERATIONS

It is certain the mineralized occurrences on Iron Range mountain occur in zones of mineralization striking in a general way north and south and standing vertically or inclined at very high angles to the west. These zones so far as known are confined to a narrow, band-like area 6 miles long, in which natural and artificial outcrops are comparatively rare. Individual zones are known to be at least 200 yards long, some are probably longer than this, but it is highly improbable that any one zone extends throughout the whole length of the mineralized band. Some of the mineralized zones are not less than 60 feet broad, others are possibly much narrower. In places at least three distinct zones occur across the breadth of the band-like area and it may be that as many or more distinct zones occur in most places, for much of the band-like territory is drift-covered.

The individual zones are for the most part represented by limited artificial exposures so widely separated from one another that it is seldom by any means reasonably certain that two successive exposures do or do not belong to a single zone. At many of the exposures no body of iron ore is visible, even though in some cases pure or nearly pure hematite is very abundant in seams and small masses distributed over widths of as much as 50 feet. In other cases, bodies of hematite of good quality are evident with widths of from 3 or 4 feet to as great as nearly 20 feet, but the individual bodies have not been traced for lengths of more than 10 or 15 feet.

The available exposures are too limited both in number and size to indicate whether some zones are uniformly barren and others are characterized by the presence of workable bodies of hematite along parts or perhaps even nearly the whole of their lengths. Several shafts sunk in bodies of hematite have shown these bodies to persist to the bottom of the shafts, but no greater depth than 35 or possibly 50 feet has been reached except in the case of the diamond-drill hole on the Keepsake claim and in this instance the available information is not precise in character. One crosscut showed an 8-foot body of hematite to decrease to a width of 4 feet in an horizontal distance of 10 feet.

The amount of available information is quite insufficient to permit of making any estimate of the amount of minable ore likely to be present. The O-Ray shaft is sunk on the widest known ore mass, in this case 18 feet wide. If this body continues for only 100 feet with the same average width, it would have to maintain this length and breadth to a depth of over 1,000 feet to yield 250,000 tons of ore. An ore-body 4 feet wide would need to be 450 feet long to yield the same tonnage with the same depth of over 1,000 feet. It is very improbable that a short ore-body 20 feet wide would maintain this width for a depth as great as 1,000 feet. Unless, then, the ore-bodies are long, or wider bodies remain undiscovered,

or certain areas are characterized by a number of relatively small bodies so situated with respect to one another as to permit of economic mining methods, it is evident that the deposits on Iron Range mountain are only of slight prospective value.

In this connexion it seems worth while to tabulate the known occurrences showing ore of a width of 4 feet or more.

American Flag shaft, 10 feet of ore or more. O-Ray shaft, 400 yards south of above, 18 feet of ore. Trench, 70 yards south of above, 6 feet of ore. Maple Leaf shaft, 800 yards south of above, 6 feet of ore reported but not seen.
Keepsake claim, 750 yards south of above, 8 feet of ore decreasing to 4 feet in horizontal distance of 10 feet.
Pacific claim, 3,000 yards south of above, two outcrops, each of 4 to 8 feet of ore.

The ore occurrences lying in line with those on Iron Range mountain, but situated several miles southward, on the south side of Goat river, at the head of Thompson creek, are reported to be of the same type, but relatively richer in magnetite and still more poorly exposed. Indications of the existence of similar deposits are reported to occur at intervals over a farther distance of several miles on the west side of the summit of the Moyie range in the vicinity of the headwaters of Russell creek and Little Moyie river.

FORT STEELE MINING DIVISION

(41) Lamb Creek

On Lamb creek, near Moyie and about 2½ miles from the railway, limonite outcrops in several places.[1]

(42 a) Bull River Iron Ore Deposits

(*See* Figure 25)

LOCATION

The Bull River iron ore deposits occur on Fenwick mountain in Fort Steele mining division in southeastern British Columbia. Fenwick mountain is the northwest end of a short mountain range which terminates at Bull river and is part of the east face of the Rocky Mountain trench here occupied by the southward-flowing Kootenay river. Bull river flows west and joins Kootenay river at the town of Bull River on the Kootenay Central branch of the Canadian Pacific railway.

From Bull River town two roads run by circuitous routes easterly up either side of Bull River valley and join one another by a bridge over Bull River canyon at the base of Fenwick mountain about 5 miles, in a straight line, from the river's mouth. An old trail leaves the road on the south side of the river at a place about one-half mile from the bridge at the canyon and rising on the face and side of a spur of Fenwick mountain, ends about 500 feet below the ridge-like summit where the outcrops of iron ore occur. The narrow ridge here attains an elevation of about 6,500 feet above sea-level, extends in a northwest-southeast direction, and falls steeply on the southwest side to Bull River valley 3,000 feet below. The property lies along the summit of the ridge and consists of eight Crown-granted claims and fractions.

[1] Smith, A.J.: in "Iron Ore Occurrences in Canada"; Mines Branch, Dept. of Mines, Canada, vol. 2, p. 26.

HISTORY

The iron ore occurrences on Fenwick mountain were staked in 1901, but had been discovered a number of years earlier. A limited number of the mining locations have been Crown-granted and are now controlled by Mr. J. T. Laidlaw of Cranbrook, B.C., and his associates. The development work on the claims consists of a number of small, shallow trenches and rock cuts on the Goliath and Hematite claims.

Previously published accounts of the deposits are few in number. The following list of titles is believed to be complete.

Dawson, G. M.: "Preliminary Report on the Rocky Mountains between latitudes 49° and 51° 30'"; Geol. and Nat. Hist. Surv., Canada, 1866, p. 151. Mention is made of the occurrence of boulders of hematite along Bull river.

Ann. Rept., Minister of Mines, B.C., 1901, pp. 1,005 and 1,007-8. Gives brief statements regarding the development work being done and the general nature of the deposits.

Pollen, C. H.: "The Bull River Iron Mines"; B.C. Min. Rec., vol. 10, pp. 621-624 (May, 1903).

Leach, W. W.: Geol. Surv., Canada, Sum. Rept. 1902, p. 181. Gives a very short account of the occurrence.

Ann. Rept., Minister of Mines, B.C., 1904, p. 108. Reference is made to the staking of further claims on Fenwick mountain.

Lindeman, E., and Bolton, L. L.: "Iron Ore Occurrences in Canada"; Mines Branch, Dept. of Mines, Canada, vol. 2, pp. 25-26. Contains a brief mention of the deposits based on published accounts and information received.

Langley, A. G.: "Eastern District (No. 5)"; Ann. Rept., Minister of Mines, B.C., 1920, pp. 117-118. Contains a description of the ore occurrences.

Allan, J. A.: First Ann. Rept. on the Mineral Resources of Alberta; Edmonton, Alberta, pp. 67-68. Contains information supplied by owners of property.

Schofield, S. J.: "The Ore Deposits of British Columbia"; Trans. Can. Inst. Min. and Met., vol. 24, p. 96 (1921). Contains a statement regarding the mode of origin of the deposits.

GENERAL GEOLOGY

The base and greater part of Fenwick mountain is composed of dark slates and fine-grained quartzites which in the canyon of Bull river are thrown into a series of close but open folds. On the slope of the mountain in the vicinity of the trail leading to the iron ore mining claims, the dark strata seem to have a general easterly dip and towards the summit of the ridge are conformably overlain by yellowish weathering limestone with interbeds of sandy limestone, sandstone, and shale. Both the limestone series and the underlying slates and quartzites are presumed to be of Precambrian age.

The observed ore occurrences are confined to a limited area represented by Figure 25. This area is largely bare of trees or brush. Rock exposures are common along the ridge summit and the upper edges of the northeastern slope and of the northern part of the southwestern slope. Elsewhere bedrock is largely concealed by drift and talus material. The strata are mainly thinly bedded, yellowish weathering, grey, dense limestones and calcareous sandstones. Light and dark coloured shales occur and, also, dense, hard, siliceous beds. The measures for the most part dip regularly east-southeast at angles varying between 20 and 35 degrees, but in places, as along the northeast slope in the general vicinity of the local summit of the Goliath claim, the strata are much sheared and the direction and angle of dip are variable.

Commencing on the narrow summit of the ridge, near the northwest boundary of the Goliath claim, at the locality marked A on Figure 25 and extending easterly to the locality marked B on the same figure, are outcrops of dark, rather fine-grained, much altered igneous rock. At locality B, the outcrops cease at the edge of a talus and drift-covered slope, but

farther east, at locality C, exposures of the igneous rock occur within a limited area. Beyond this point, along the strike, no rock outcrops for a long distance. The igneous body is about 50 feet thick and seems in the western part to be steeply inclined to the southwest. The mass has somewhat the appearance of a sill, but at locality A it cuts across the strata both along the strike and dip and, therefore, is presumed to be a dyke.

DESCRIPTION OF THE ORE OCCURRENCES

The ore consists of hematite and with a small, variable amount of vein quartz, it occurs in the igneous dyke and bordering strata exposed between localities A and B, and in the vicinity of locality C. It also occurs in sedimentary beds revealed in a number of shallow trenches and rock-cuts at localities D and E on the otherwise nearly exposureless southwest slopes.

At locality A on the axis of the ridge, the strata bordering the igneous body are, in part, dense, pale grey, faintly greenish, siliceous rocks, stained red or brownish on weathered surfaces. In places near the dyke, these siliceous rocks hold small bodies of hematite varying in size from mere specks to some that are several inches long. In general shape they are ovoid, but in cross-section they have either irregularly curving or angular outlines. The hematite in these bodies is very fine-grained and is dark greyish black because of the large amount of fine-grained silica present. The bodies in some places are sparsely distributed; in others they are closely set, nearly touching one another, and many have outlines that suggest they are due to the coalescence of two or more bodies. They do not seem to be connected with one another nor with any fracture or vein system. Similar bodies were observed in dense, siliceous strata and in limestone in the trenches on the southwest slope and in the natural rock outcrops farther to the northwest. These small bodies may be accretions that formed with the enclosing rock. Near the edge of the dyke, the dense, siliceous strata in places are traversed by discontinuous, curving or reticulated, thin, seam-like bodies of nearly pure hematite. These are seldom more than a few inches in length and one-eighth inch in breadth. In places they are closely set and except for their curving, minutely intricate courses, appear as if developed along planes of fracture in shattered rock. The igneous rock is sheared and much of it is stained or impregnated with hematite. In places it is distinctly cut by veins of hematite, some as much as several inches in width. Such veins also appear in the bordering sediments.

Elsewhere along the edges of the igneous body, the bordering limestone and associated beds are impregnated and replaced by hematite in varying degrees and to varying distances, but nowhere, except at one place, is anything developed worthy of being considered iron ore. In places, short, gash-like veins of quartz cut the sediments and igneous rock. So far as observed, any hematite appearing in these veins occurs along fracture planes.

On the axis of the ridge, bordering the dyke on its southern side, is a body of hematite with a width of 8 feet and an exposed length of the same dimension. Parts of the body are nearly pure hematite, dark red, very dense, but much fractured and slickensided. In part, the body shows vague patches of partly replaced country rock, some of it showing the

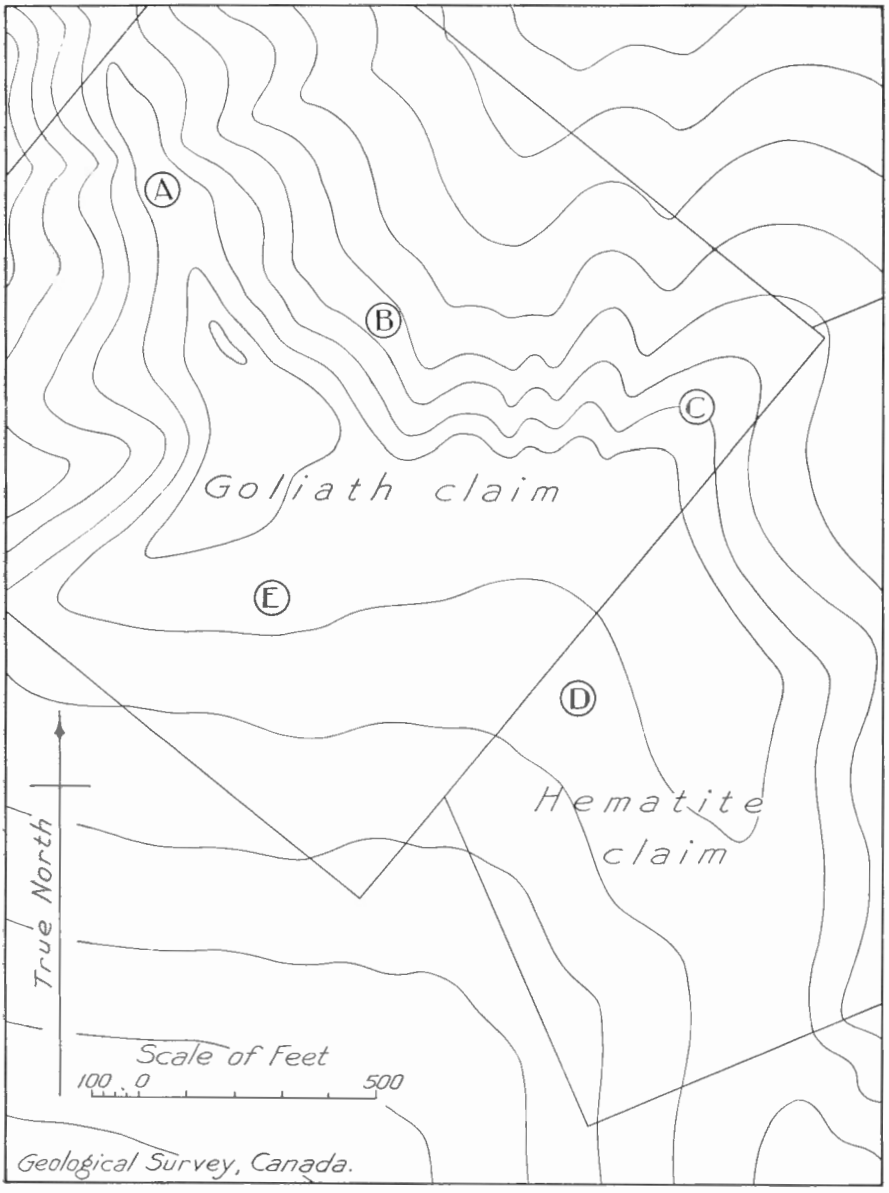

Figure 25. Iron ore occurrences, Fenwick mountain, Bull river, Kootenay district, B.C. Localities referred to in text are indicated, respectively, by letters A, B, C, D, and E. Contour interval, 100 feet.

small accretions of hematite. Narrow, gash-like veins of quartz are also present. This is the only body of ore seen. It clearly terminates to the east, but to the northwest all exposures cease and it may be, though it seems unlikely, that the body continues in that direction down the steep slope.

In the artificial exposures at localities D and E, on the southwest slope of the ridge, the same general phenomena are visible as in the vicinity of the dyke, but nowhere is any ore-body visible. In some places, 25 per cent or more of the volume of particular layers of limestone a few inches thick consists of the irregularly ovoid hematite accretions and in some instances the bodies are so numerous as to constitute almost solid layers of hematite several inches thick.

MODE OF ORIGIN

Former describers of the hematite occurrences on Fenwick mountain have referred to them as being of the nature of veins, impregnations, or replacements. They have also been referred to as examples of bedded deposits, originally composed of limonite since changed to hematite.

The ore occurs in short veins cutting the igneous rock and the sediments; it occurs in seams along what appear to be planes of fractures traversing dense, siliceous strata and quartz veins; and it also occurs impregnating and replacing sedimentary strata. In addition, a less pure form of hematite occurs in small bodies in the sediments. These small bodies may also be impregnations or replacements, but perhaps are ferruginous accretions which grew while the enclosing sediments were being formed.

The purer hematite that occurs in veins cutting the igneous rock and in seams along fracture planes in quartz veins cutting the igneous rock, must have formed after the intrusion of the igneous body. The one comparatively large mass of ore on the ridge top at the southeast edge of the dyke and the hematite seams in the shattered, dense, siliceous rocks presumably formed at the same time as did the veins in the igneous rock and the seams in the fractured quartz veins. The hematite that impregnates and partly replaces the sediments along the edges of the dyke resembles, in general character, the hematite of the veins and seams and the impression was received that all this hematite had formed at essentially the same time after the intrusion of the dyke. But all these modes of occurrence on the northeast slope seem definitely connected with the edges of the dyke. The veins, seams, impregnations, and replacements occur only along these edges and in the case of the layers showing replacement, the hematite decreases in amount outwards from the dyke.

The small, accretion-like bodies of impure hematite may belong to an earlier generation than the veins, seams, and replacement masses of purer hematite. Within the body of hematite on the ridge top at locality A are small masses of unreplaced rock, some of which carry the accretions and give the impression that the accretions were in existence prior to the commencement of the process of replacement. The accretions as developed on the southwest slopes characterize a particular horizon in the sediments, 50 feet or more thick, and this is the horizon of the strata on the ridge summit at locality A where the same type of bodies also occurs. If it were certain that these accretions were confined to this particular horizon in the strata then it would be reasonably established that the accretions were original constituents of the sediments. Unfortunately the requisite

observations were not made in the field and it cannot be affirmed that the accretions are thus limited in their distribution, although this was the impression received. It is thought that the accretions originated with the enclosing sediments and that the hematite occurring in seams and veins as replacements of the strata formed much later, after the strata had been penetrated by the dyke and after the formation of the quartz veins. But since the quartz veins and the presumably later formed hematite seem to be intimately associated, it seems probable that they are also associated in origin.

ECONOMIC CONSIDERATIONS

No body of ore of sufficient size and purity to warrant development work is exposed on the Goliath or Hematite mining locations, nor is there apparent any valid reason for supposing any such body to be present either beneath the surface or at the surface but concealed from view.

One small mass of ore, apparently of merchantable quality, occurs on the ridge summit near the western border of the Goliath claim at locality A. This mass is 8 feet wide and is exposed for about the same length. Its boundaries are visible on all sides except towards the west. It may extend some distance in that direction down the steep drift and talus-covered, southwest slope of the mountain. A very slight amount of trenching would be sufficient to determine whether or no the body does extend in this direction. This body occurs on the edge of a dyke running eastward along the northeast mountain slope. The dyke is exposed for a short distance between localities A and B and again at locality C, elsewhere the dyke is drift-covered. Along its exposed edges the strata for a variable distance, never more than a few feet, carry hematite, but nowhere is there merchantable ore either as regards quantity or quality. On the southwest slopes, in the vicinity of localities D and E, a small number of shallow trenches expose strata which for thicknesses of a few inches are of tolerably pure hematite but nowhere is anything exposed that is worthy of being called ore.

A part, if not all, of the hematite occurs in veins, seams, and as replacements of the sediments, especially in the vicinity of the dyke. It is possible that elsewhere in the district comparatively large bodies of merchantable ore may have formed in this fashion. A number of years ago the discovery of a body of hematite said to be 10 feet thick was reported from Dibble creek, a tributary from the north to Bull river. Stories are current in the district of the occurrence of hematite on other tributaries of Bull river, but no precise information was received as to the position of any of these rumoured occurrences.

(42 b) Sand Creek Iron Ore Deposit

(*See* Figure 26)

LOCATION

The Sand Creek iron ore deposits occur in the valley of Sand creek in Fort Steele mining division, southeastern British Columbia. Sand creek flows in a general southerly direction and enters Kootenay river from the east. The main branch of the stream crosses the Crows Nest branch of the Canadian Pacific railway about one mile east of Gallo-

way station and heads in and flows for some miles through a narrow valley trending southeast. The ore outcrops are situated on the west side of the valley, 8 or 9 miles northeast of the railway.

At Barnstead's mill between Jaffray and Galloway station, a wagon road leaves the highway paralleling the railway and follows up Sand creek to a lumber camp. From there a trail continues up the valley and about 2½ miles beyond the lumber camp passes through a small opening in which stands a deserted cabin. The ore occurrences lie on the lower slopes of the west side of the valley at this point and may be reached by a short trail which commences opposite the cabin but is partly obliterated as the result of lumbering operations.

HISTORY

The property was located some years ago when several short tunnels were driven and a few open-cuts made. One or two shallow diamond-drillholes were also sunk on behalf of Dr. Ings of Calgary. More recently the property was relocated and sixteen claims were staked for Messrs. R. E. Beattie, E. Patterson, C. R. Ward, and other residents of Cranbrook, B.C. Since then a number of shallow trenches have been dug.

The following list contains the titles of such published statements as have been noted and that make more than a passing reference to the ore occurrences.

Lindeman, E., and Bolton, L. L.: "Iron Ore Occurrences in Canada," vols. 1 and 2; Mines Branch, Dept. of Mines, vol. 2, p. 26 (1917). A very brief description based on information supplied by owner or locater of the property.

Langley, A. G.: "Eastern District (No. 5)"; Ann. Rept., Minister of Mines, B.C., 1919, pp. 115-117. A general account of the ore occurrence.

GENERAL GEOLOGY

In the immediate vicinity of the ore occurrences rock outcrops are scarce. On the southeast side of Sand Creek valley, the high, bare mountain ridges are of Palæozoic limestones, whereas on the opposite northwest side, the ridges and higher slopes are largely of dark slates and fine-grained quartzites of, presumably, Precambrian age. The strata on the western side have a general westerly dip, the Palæozoic measures on the eastern side plainly lie in open folds trending northwest-southeast. Possibly the contact between the two groups of strata is a fault or series of faults striking along the intervening valley.

The iron ore occurs in pale grey, nearly white, quartzites in part very fine-grained, in part somewhat coarser, so that the component round quartz grains are plainly visible. These measures apparently are underlain by reddish shales and calcareous beds with interbeds of grey quartzite. The whole assemblage may be several hundred or more feet thick and seemingly is underlain and overlain by black slates and dense quartzites. The strata dip to the southwest at angles varying, for the most part, between 50 degrees and 10 degrees and are traversed by faults paralleling the strike of the strata.

DESCRIPTION OF THE ORE OCCURRENCES

The iron ore is a hematite and is visible at three localities, whose positions relative to one another and to Sand creek are shown in Figure 26. The most northerly locality (locality "A", Figure 26) lies on a wooded slope at an elevation of about 600 feet above Sand creek and 500

yards distant from it. At this point a trench 15 feet long has been opened across the strata and ends in a shallow pit from which an opening several feet deep extends into a rock face. This face is composed of fine-grained, bedded quartzite dipping into the hill at an angle of 47 degrees. At the bottom of the pit is a bed-like body of hematite about 12 inches thick. It has the same dip and strike as the overlying quartzites which for a thickness of several feet are stained red and pink and contain streaks, blotches, and irregular areas sparingly impregnated with hematite. Beneath the hematite band are highly crumpled and sheared, soft, argillaceous rocks, stained reddish and in part almost clay-like.

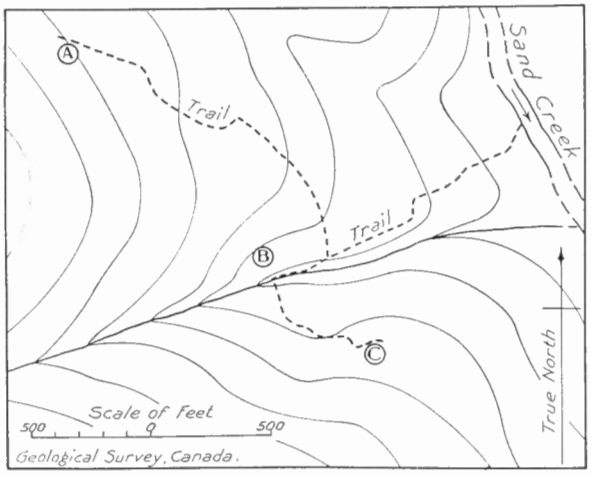

Figure 26. Sand Creek iron ore occurrences, Kootenay district, B.C. Localities referred to in text are indicated, respectively, by letters A, B, and C. Sketch contours are at approximately 100-foot intervals.

The hematite of the 12-inch layer contains a little vein quartz in the form of highly fractured veins. The ore is fractured and slickensided planes are visible. The material is red, fine-grained, compact, and seems to carry considerable finely disseminated quartz.

About 10 feet in front of the entrance to the cut, a 6-foot hole exposes a wide mass of vein quartz containing little or no iron ore. The vein crosscuts the strata which on the hanging-wall side consist of red, crumpled, shaly material holding irregular patches and stringers of vein quartz.

The hematite layer dips into the hill-side at an angle of 47 degrees and it and the enclosing strata strike along the hill-side. The rock face in which the ore now shows approximately marks the plane of a nearly vertical fault which cuts across the strata at a small angle. The quartzites and hematite layer are on the up-hill side of the fault and dip downwards into the hill. The strata occurring down hill from the fault-plane lie in the relatively uplifted fault block and except at the open-cut which has been broken across the fault conceal the hematite band because the measures of the lower slopes act like a thick veneer applied along the fault-plane, thus concealing the down-thrown layer of ore. The strike of the strata and of the fault and the course of the hill-side nearly coincide in direction, so that the horizon of the ore layer may not again come to the surface or not until the ore has died out.

Northeastward for a distance of 1,000 feet along the line of strike, a number of shallow trenches, some quite short, have been dug so as to crosscut the measures and show reddish and grey shales, red and grey schistose limestones, and beds of red and grey quartzites. Similar beds are exposed just below the open-cut showing ore and all these reddish strata presumably occur east of the fault-plane, lie in the uplifted fault block, and belong to horizons lower than that holding the hematite layer. The reddish colouring of these rocks is due to iron oxide, but is not an indication of the possible existence of an iron ore bed. Higher on the hill-side are exposures of the grey quartzites belonging to the relatively uplifted side of the fault, but it is possible and quite probable that the iron ore horizon nowhere comes to the surface, but is everywhere concealed from view by the relatively uplifted reddish beds.

To the southeast for a considerable distance rock outcrops are rare. About 1,200 feet southeast of locality "A" and almost on the line of strike of the strata, two short tunnels have been driven into the hill on the northwest slope of a gully. The tunnels at this place (locality "B" on Figure 26) were commenced in drift and since have caved in. At the entrance of the more southerly tunnel, on one side at the floor-level, is exposed a layer of hematite about 20 inches thick overlain by quartzite. The layer is terminated by a series of faults, so that it outcrops only at this point where it ends wedge-like. It dips into the hill and probably soon sinks below the level of the floor of the tunnel. At this place, as at the more northerly locality "A", the ore layer is exposed along a fault-plane and although the layer may extend to the north and south it is questionable if it again comes to the bedrock surface. It is quite probable that both to the north and south it is sealed from view by relatively uplifted strata occurring on the down-hill side of the fault-planes.

On the opposite, southern side of the gully at locality "B", not far above the stream bed, is an exposure of quartzites dipping southwest at an angle of 15 degrees. The rock carries considerable pyrite and is much stained with iron rust. One band of rock is now represented by a layer 12 inches thick largely of porous limonite and hematite. In this layer detrital quartz grains are abundant and there are also small patches of relatively unaltered quartzite rich in grains and crystals of pyrite. Such patches fade into the surrounding porous ore which also carries remnants of the pyrite and limonitic pseudomorphs after pyrite.

The southernmost ore outcrop (locality "C", Figure 26) is 600 feet southeast of locality "B" or 1,800 feet southeast of locality "A". All three occurrences lie nearly in a line corresponding with the direction of the strike of the strata. This third ore outcrop is 300 yards southwest of Sand creek and 350 feet above it. At this point, a cutting 35 feet long extends into the hill-side and ends in a rock face 20 to 30 feet high. The rocks are fine-grained quartzites which dip southwest into the hill at an angle of 10 to 15 degrees. A band of hematite occurs at the inner end of the cutting and, conforming to the strike and dip of the enclosing strata, continues outward along the sides of the cut to its mouth where it disappears under drift. The quartzites bounding the hematite layer are stained and traversed by films of the iron oxide. On the southwest side of the cut, much vein quartz in places borders the ore. This quartz is greatly fractured and much hematite occurs along the partings. There is some evidence of slipping and faulting in the strata, but it is difficult to determine

the structure because the cutting has been timbered and partly covered in and nearby rock exposures are wanting.

The layer of hematite in the northeast wall of the cut is 3 feet thick. The ore is dark red and blackish, very fine-grained, minutely scaly, compact, and carries considerable quartz in minute grains. It is much fractured and slickensided partings are numerous. The ore was uncovered for a few feet along the strike at the mouth of the cutting and within a distance of 6 feet was found to markedly decrease in thickness while vein quartz rapidly increased in volume and finally the ore layer seemed to grade into quartzite heavily stained and impregnated with hematite.

Evidence of slipping and minor faulting is plainly visible at locality "C" and it is possible that the ore layer does not extend into the hill, but is cut off in that direction by a fault. On the hill-side above the trench and about 100 yards away, is the site of one or both of the diamond-drill holes which some years ago were sunk on the property. It has been stated that the results obtained by drilling were unsatisfactory, either because the drilling was mismanaged or because the information gained was disappointing.

To the southeast of locality "C" exposures are lacking until at a distance of 1,600 feet two trenches show white quartzite and reddish shales and limestones. Similar strata are poorly exposed just below the open-cut. It may be that to the southwest the ore horizon nowhere comes to the surface because of faulting.

ORIGIN

At the three places where the hematite is visible, the ore-bodies appear as beds conforming in strike and dip to the enclosing strata. At each place the ore carries minute quartz grains such as compose the associated quartzites and at the southernmost locality the ore bed along the strike seems to grade into quartzite. In these respects the ore behaves as a bedded deposit contemporaneous in origin with the enclosing sediments.

At the locality in the gully between localities "B" and "C," the porous limonite and the iron-stained and impregnated quartzites still hold abundant pyrite from which, presumably, the limonite was derived. Possibly the hematite of the three bed-like occurrences is also secondary, but at these places no pyrite is visible and it would be peculiar if the pyrite had been completely destroyed. It is conceivable, however, that the hematite layers may represent beds once rich in pyrite which was converted into limonite subsequently metamorphosed to hematite. Possibly the vein quartz so intimately associated with the hematite layers may be of related origin and the ore beds be local replacements of the sediments.

The observed facts do not seem to warrant drawing any precise conclusions as to the mode of origin of the layers of hematite.

ECONOMIC CONSIDERATIONS

The hematite ore is exposed in three places and each place behaves as a bed. At the southernmost locality the ore may be seen to decrease in thickness and to rapidly grade into quartzite, thus showing that the ore beds, however they may have formed, do not continue indefinitely. The three exposures seem to occur at very nearly the same horizon and perhaps do occur at precisely the same horizon. The thickness of ore at

one locality is 1 foot, at a second, 2 feet, and at the third, 3 feet. If it be assumed that the three outcrops occur at the same horizon, then it follows that at this horizon, in a distance of 1,800 feet, the ore is first exposed with a thickness of 3 feet and rapidly in a length of 6 feet dies out, is developed again some distance farther north where at one place it is 2 feet thick, and still farther north it is 1 foot thick. An iron ore-body of such dimensions if it were developed in unfaulted ground would not pay to mine. But at two of the outcrops the ore is unmistakably faulted and there is presumptive evidence that it is faulted at the third locality. In such circumstances, the cost of mining would be further increased.

Possibly the bed or beds increase notably in thickness along the strike or dip of the strata or in both directions, but unless cogent reasons are forthcoming for strongly indicating a probable not a possible material increase in thickness, costly exploratory work necessary to decide the question would be unwarranted. Faults occur at the ore outcrops and presumably other undetected faults occur. Rock exposures are few in numbers and quite insufficient to determine the structure with sufficient exactness. Unless the structure is known beforehand any exploratory work undertaken might produce negative results only. To determine the structure beforehand in the general absence of rock exposures would involve much stripping and trenching which of itself might prove costly, for the drift cover is quite thick in places.

Prospecting might be carried on along the strike of the strata in the hope that somewhere in that direction the ore might be developed in greater volume. It is reported that ore occurs several miles up Sand creek on the eastern side of the valley, but no precise information was forthcoming regarding the location or character of the alleged discovery. It seems possible that rust-stained strata or slightly ferruginous beds may have been found and thought to mark the occurrence of an important ore-body.

CARIBOO MINING DIVISION

(43) Finger Lake, Iron Mountain Group

Source of Information. Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1921, pp. 110-111.

GENERAL DESCRIPTION

"An occurrence of hematite iron ore in the vicinity of Finger lake . . . . was found to be much smaller than had been expected and . . . . the showings are not particularly promising. The showings are situated on a small hill on the north side of Finger lake . . . . about 40 miles from Vanderhoof. . . . The iron ore occurs as hematite and specularite in sheared zones. . . . The rock . . . . exposed on Iron mountain consists entirely of volcanic rocks. . . . In . . . . zones small stringers and bunches of hematite have been deposited, apparently by replacement action. The stringers of solid hematite are only a few inches wide . . . . in addition there is a certain amount of disseminated ore. . . . This material . . . . occurs in widths up to 2 or 3 feet, but is not continuous for any great length." . . .

PEACE RIVER MINING DIVISION

(44) Cameron River

Source of Information. Galloway, J. D.: Ann. Rept., Minister of Mines, B.C., 1923, pp. 135, 145-146.

GENERAL DESCRIPTION

The deposits . . . . "consist of spring deposits of bog iron ore . . . . small in size and very scattered. . . . In many places they only consist of impregnations of iron oxide staining the surface gravels and clays. (Though) all the deposits were not seen . . . . the conclusion is that . . . . (they) are of no commercial value as a source of iron ore . . . . at . . . . (the) present . . . . or at any reasonably future time. . . . (They) are situated on Cameron river . . . . at intervals along the valley . . . . all the way from its head . . . . to where it joins the Halfway river, a distance of 30 to 40 miles. A number of the outcrops were examined at a point about 10 miles up Cameron river. . . . (These) consist of isolated, small, circular masses of bog iron which is relatively pure near the centre, but grades off into iron-stained gravels and clays on the outside. Each (originates) . . . . from a central spring, the water of which contained iron in solution. . . . At various places . . . . over an area of about 1,000 feet by 500 feet small outcrops of iron ore and iron-stained clay occur. It is quite apparent . . . . that nowhere is the iron ore continuous for any appreciable distance. . . . Throughout the (underlying Cretaceous) sedimentary formation there is a certain amount of iron . . . . as clay ironstone. . . . The Bullhead Mountain formation contains many narrow lenticular bands and concretions of this material. It is probable that the iron in the spring water is derived . . . . from this clay ironstone." . . . .

CHAPTER IV

IRON ORE OCCURRENCES, WEST COAST OF VANCOUVER ISLAND

By W. L. Uglow

INTRODUCTION AND ACKNOWLEDGMENTS

Iron deposits have been known for many years to occur in the vicinity of the west coast of Vancouver island, from Sooke peninsula to Quatsino sound, and geological literature contains very many references to them. They have been the subject of several brief reports, chief among which are those by Carmichael[1] (4) in 1902, Lindeman (15) in 1907, and Brewer (17) in 1916. Each of these constitutes a valuable record in that it outlines the condition of the properties at the time of the investigation; but each fails of completeness in the same particulars, namely, that the deposits are treated almost entirely from a commercial standpoint and scarcely at all from a geological aspect, and also that none of the reports is accompanied by a set of property maps indicating the size and geological character of the deposits.

For the purpose of obtaining this information and preparing a complete report, the writer was instructed by the Director of the Geological Survey to spend the field season of 1924 in making detailed geological examinations and surveys of the various west coast deposits, to supply detailed maps and sections of the principal ones, and to make estimates of their available tonnage and prospective value.

The work was carried on with the aid of four technical assistants, acting from a 60-foot motor launch as a base. All of the main deposits were surveyed by means of a telescopic alidade and plane-table and the mapping was conducted on scales varying from 20 to 120 feet to the inch. Geological maps and sections were constructed in the field and depict actual field facts as they are accessible to observation at the present time. From these data, interpretations were made and conclusions were drawn giving the writer's judgment of the value of the various deposits as possible sources of iron ore. Twenty-eight deposits were carefully investigated and maps of some fifteen of them accompany this report.

Grateful acknowledgment is made of the valuable assistance rendered by W. M. Brewer, Resident Mining Engineer of Western Mineral Survey District (No. 6), in providing information leading to the discovery of many of the old deposits and in arranging for guides; by G. G. Aitken, Chief Geographer, Department of Lands, Victoria, in furnishing the party with maps of the west coast and plans of surveyed mineral claims; and by many residents and claim owners who assisted as guides. To the assistants, C. S. Evans, geological engineer, and F. F. Osborne, mining engineer, especial credit is due for the painstaking care with which they delineated the boundaries of each deposit, thus leaving the writer free

[1] Consult Bibliography, page 158, for all references.

for geological investigation and for the work of general supervision. Especial acknowledgment is also given to J. G. Pearcey and W. A. Bain who had charge of the plane-table mapping and draughting.

Most of the development work was done on the iron deposits from fifteen to twenty years ago, so that the luxuriant growth of salal and other underbrush, combined with caving of tunnels and open-cuts, has rendered many of the old workings difficult to find and impossible of access.

PREVIOUS WORK

In 1885, Dawson carried on the first geological work of note along the west coast of Vancouver island, by making a systematic study of the rocks exposed along the shore from cape Scott at the northeast extremity to, and including, Quatsino sound. His report (2) is accompanied by a geological map of this part of the island, and here, as elsewhere, his work still stands as one of the leading contributions to the regional geology of British Columbia. He makes no reference to the iron deposits of Quatsino sound.

In his report on "The Mineral Wealth of British Columbia" (3) Dawson described briefly an occurrence of magnetite on Sooke peninsula close to the southeast end of the island. No reference is made to the discovery of the deposits nor to any previous literature on the locality.

Attempts to initiate an iron and steel industry on the Pacific coast, commenced in 1880 when a small blast furnace "was erected at Irondale in the state of Washington, for the manufacture of pig iron. It had a daily capacity of 10 tons and was a hot-blast charcoal furnace. It was operated for six months, and then was replaced by a 50-ton furnace, which a few months later was reconstructed and for years turned out a good grade of pig iron, until in 1891 it was closed down. In 1901 Pennsylvania capital was interested in it. The Pacific Steel Company was organized to acquire and operate it. The plant was modernized and about $100,000 expended on it, and in December, 1901, the manufacture of pig iron was resumed."[1] Although this attempt was not a commercial success, it gave a great stimulus to prospecting iron deposits along the coast of British Columbia, and directed considerable attention to the possibilities of such deposits. The Pacific Steel Company undertook the investigation and development of some of these deposits, principally those on Sechart peninsula, Copper island, and Sarita river.

In 1897 Kimball (5) published the first geological description of these iron deposits in a paper dealing chiefly with the problem of genesis. He states that, "the occurrences here referred to clearly conform to two separate types of ferriferous deposits which it has seemed important to distinguish as hydro-chemical replacements. . . . One type is a morphological replacement of limestone by double decomposition between ferrous salts and calcic carbonate, the former being generated from ferrous silicates; the other type, a partial, and not necessarily pseudomorphic, replacement of ferrous silicates in weathered basic rocks, or as more explicitly distinguished, a residual concentration or fixation of iron oxides incidental to development of soluble alkaline carbonates from weathering oxidation or splitting up of ferriferous silicates. In replacements of limestone

[1] *See* General Review of Mining in British Columbia, Bull. 19, Victoria, B.C., quoted in "Iron Ore Deposits of Vancouver and Texada Islands, British Columbia," by E. Lindeman, 1901, p. 7.

ferriferous material is generally derived from extraneous though contiguous sources through simple permutations and reactions."

Of the Vancouver Island deposits, he describes the Sarita River occurrence (Logan location) with a section, and an occurrence at Sechart with two sketches (either Crown Prince or Bald Eagle deposit). These are both classified as replacements of limestone. Reference is also made to the occurrence described by Dawson near Sooke harbour, and this is described as belonging to the second group mentioned above.

In 1902, Webster (7) and Haycock (8) made a geological reconnaissance of the west coast of Vancouver island from the vicinity of Victoria northwesterly to and including Nootka sound. Their field mapping was done on the Admiralty charts, but unfortunately no geological maps accompany their reports. They state that the outline of the geology given by Dawson for the north end of the island applied in general to the coast line they examined: but Webster believes that the crystalline limestones which Dawson includes with the Vancouver series belong to an unconformably older formation. He also states that "the tracing of the boundaries of these various limestone bands is of importance, as almost invariably the deposits of iron and copper ores are found at or near the contact of the limestones with the igneous or volcanic rocks."[1] Both writers give brief descriptions of the Newton magnetite deposit on Gordon river and of the magnetite deposit on Copper island, Barkley sound; and Haycock mentions the occurrence of magnetite on Sooke peninsula.

The first systematic investigation of the iron deposits of the west coast of Vancouver island was undertaken in 1902 by Carmichael (4) for the Department of Mines, British Columbia. In his report Carmichael outlines briefly the economic and industrial aspects of the iron and steel situation of the Pacific Northwest, summarizes the geology of the west coast as laid down by Dawson, and gives detailed descriptions, in some cases accompanied by sketches and plates, of the deposits on Nootka sound, Hesquiat lake, Sechart peninsula, Henderson (Anderson) lake, Alberni canal, Sarita river, Copper island, Bugaboo creek, Gordon river, and Sooke peninsula. A table is also submitted giving complete analyses of samples from most of the deposits described.

The magnetite deposits of Vancouver island were again the subject of detailed investigation in 1907 when Lindeman (16) examined the principal locations for the Dominion Department of Mines. His report contains descriptions of most of the deposits examined by Carmichael, accompanied by a few analyses, as well as statements of the amount of development work done upon each one. It provides, also, a magnetometric map of the Iron Chief or Western Steel claim on Sechart peninsula; and the first authentic description of the limonite deposits of Quatsino sound.

During the summers of 1908, 1909, and 1910 Clapp (17) was engaged in making the first systematic geological reconnaissance of the southern part of Vancouver island for the Geological Survey. The country examined included the east coast, southeast of Nanaimo, the west coast, southeast of Barkley sound, and all the accessible parts of the island southeast of a line joining these two districts. In addition to the areal and stratigraphical geology, Clapp paid some attention to the mineral deposits, amongst which he mentions the magnetite deposits of Gordon river, Bugaboo creek, and

[1]Ibid., p. 55 A.

Sarita river. He submits no descriptions of these deposits, but outlines in a general way his ideas of their genesis and relationship to the country rocks, as follows.

"In the southern part of Vancouver island the largest bodies of magnetite occur in the Nitinat limestones. . . . The deposits of the Nitinat formation occur in the contact metamorphosed limestones at the contacts with plutonic rocks, diorite always being the contacting phase of the eruptive bodies. . . .

The metallic minerals occur usually in closest association with the sheared, contact metamorphosed limestone, in which are occasional lenses of residual marble. . . . The marble has been metamorphosed in places to a typical "contact rock" . . . . composed essentially of massive brown garnet and small grains of green diopside . . . .

The intrusive plutonic rocks are the Saanich granodiorite and the Beale diorite. . . . The diorite in the vicinity of the deposits is as a rule richer in hornblende. . . . Near the contact the diorite passes into hornblende-rich phases, fine-grained, and sometimes porphyritic in texture. . . . As the occurrence of the magnetite bodies is restricted to the contacts of the marble and the intrusive plutonic rocks, there can be little question that they owe their origin to the contact action of the plutonic rocks on the marble. . . .

The magnetite deposits of the Nitinat formation not only owe their origin to the intrusion of the plutonic rocks, but, since it seems as if the original limestones were pure, the minerals of the deposit have apparently been derived from the intruding batholith. After the limestones had been more or less contact metamorphosed, as inclusions of silicates occur in the magnetite, solutions of magnetite, with small amounts of sulphides, penetrated the contact zone, and replaced it in part. The solutions were apparently very concentrated, virtually magnetite magma, since they intruded and brecciated the sheared diorite and unaltered marbles in much the same manner as rock magma intrudes and brecciates."[1]

The above quotation from Clapp is included since it presents the earliest clean-cut explanation of the occurrence and genesis of these magnetite deposits and because of its advocacy of the ore injection hypothesis. The detailed data of occurrence recited under the subsequent descriptions of the individual deposits give the criteria by which this hypothesis of Clapp may be tested.

In 1913 Cooke (23, 24) made a detailed geological study of Sooke peninsula, and his reports contain brief descriptions of the magnetite deposits there.

The last published personal investigation of these West Coast iron deposits was made by Brewer in 1916 for the British Columbia Department of Mines (21). He gives a brief review of the history of iron ore exploration and mining on the west coast, a map of Vancouver island showing the locations of the principal properties, a description of each deposit visited with the extent of development work accomplished, and an estimate of actual, probable, and possible ore. Brewer does not include maps of the various deposits, nor does he state the mathematical basis upon which he estimates tonnages. It is interesting to note in passing the following quantities which he reports (for West Coast deposits alone): actual ore, 470,000 tons; probable ore, 1,060,000 tons; possible ore, 3,417,000 tons.

[1] Ibid, pp. 189-193.

From 1917-1920, Dolmage (26, 27, 28) made a geological survey of the west coast of Vancouver island, and his is the latest and more authoritative account of the geology of that coast. He makes passing references to a few of the magnetite deposits, but detailed descriptions are not given.

Other reports and papers dealing with these deposits are quoted in the bibliography, but none of them is based on systematic personal investigations.

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PHYSICAL FEATURES OF THE WEST COAST

The iron deposits near the west coast of Vancouver island lie in a northwesterly trending zone paralleling the main coast, and extending for a distance of 250 miles from Sooke peninsula near the southern extremity to Quatsino sound near the northwestern extremity of the island. Along its western (in reality, southwestern) shores Vancouver island presents a rugged and rock-bound front to the seas that roll in from the open Pacific

and in many places reefs and chains of rocky islands fringe the coast and make navigation dangerous. At intervals of approximately 40 miles, this bold shoreline is broken by fiord-like indentations which, with their finger-like extensions, radiate for many miles into the heart of the island. These indentations, chief amongst which are Port San Juan, Barkley, Clayoquot, Nootka, Kyuquot, and Quatsino sounds, provide splendid anchorage and shelter from the turbulent seas and low-hanging fogs that are of frequent occurrence during the winter months. This coast, therefore, which has been known for years as the "Graveyard of the Pacific", on account of the large number of wrecks for which it is responsible, presents some unusual difficulties in the way of the solution of the problem of ore transportation by water, except during the summer months.

Without a single exception the iron deposits herein described are found either within the sounds or in very close proximity to them. They vary in altitude from 70 to 2,000 feet above sea-level, and with the exception of the deposits of the San Juan district are less than 5 miles from tidewater. The country in which they occur is very difficult to traverse and full of natural obstacles for the geologist or explorer. The relief is not great, but the heavy rainfall for seven or eight months of the year, accompanied by prevailing high winds, has given rise to a very dense barricade of underbrush and an abundance of fallen timber, which in the words of one geologist makes "geological investigation wholly secondary to the problem of progression."

GENERAL GEOLOGY OF THE WEST COAST

In 1886 Dawson (2) established the fundamental facts and principles of the bedrock geology of this coast. These were elaborated and revised by Clapp (17) in 1908-1910 for that part of the island southeast of Barkley sound; and by Dolmage (26, 27, 28) for the remaining part of the coastline in 1918-1920.

The following table, based on the work of Clapp and Dolmage, summarizes the most recent information on the bedrock geology.

Table of Formations

Tertiary	Lower Miocene	Conglomerate, sandstone
	Lower Oligocene	Sooke gabbro and anorthosite
	Upper Eocene	Metchosin basalt, tuff
Unconformity		
Lower Cretaceous		Sandstone, shale, conglomerate, coal
Unconformity		
Upper Jurassic (?)	Coast Range batholith	Saanich granodiorite Beale diorite
Triassic (?)	Vancouver group	Andesite, tuff, tuffaceous argillite, limestone
Palæozoic	Carboniferous	Malahat volcanics Leech River slates

As all the magnetite deposits examined are related to the contacts of the diorite and granodiorite with the rocks of the Vancouver group, the following detailed information concerning the petrography and structure of these rocks, taken from the latest report by Dolmage, is embodied herein.

"VANCOUVER GROUP

"The oldest rocks of the district are those of the Vancouver group and these are also the most widely destributed . . . . throughout the island. The group consists almost entirely of volcanic rocks, chiefly andesites, but contains also many intercalated beds of tuffaceous argillite and limestone—some of which attain a thickness of 2,000 feet and more. .

"The volcanic rocks comprise by far the greater bulk of the group and underlie fully nine-tenths of the area under discussion. Andesites are the prevailing types, but dacites and basalts are also found, and considerable quantities of tuffs, breccias, and agglomerates. . . . The andesites . . . . are seldom found in a fresh condition. They usually contain high proportions of chlorite, actinolite, and epidote, giving the rocks a dull greenish colour, or else they contain considerable hematite which gives them a decidedly reddish to brownish tint.

"Tuffs are plentifully distributed throughout the group. They are usually well bedded and clearly indicate the attitude of the beds of the formation. They present a great variety of colour, from dark purple through shades of brown and red to light grey, but very commonly also assume various shades of dull green. They vary likewise in texture from coarse agglomerates through many gradations down to material so fine that its components can be resolved only by the use of a microscope. . . .

"The tuffaceous argillities, the least abundant rocks of the group, are always associated more or less closely with the limestones, and are confined to relatively thin beds occurring north of Kyuquot sound. . . . In the hand specimen they are fine-grained to dense, finely banded, usually black, but often grey, brown, or dark green and have a distinct cleavage parallel to the bedding. . . .

"Beds of limestone varying from a few feet to 2,000 feet or more in thickness were found at many places, interbedded conformably with the andesites and tuffs of the Vancouver group. . . . These limestones for the most part are very pure, light grey to bluish-grey in colour, and have been metamorphosed into a medium coarse, even-grained marble. . .

"The limestones, where cut by plutonic rocks of the Coast Range batholith, are intensely metamorphosed into rocks containing garnet, epidote, pyroxene, quartz. . . .

"The Vancouver group is folded into steep anticlines and synclines whose axes strike north 60 to 65 degrees west. . . .

COAST RANGE BATHOLITH

"A great many intrusions of diorite and granodiorite, some of considerable extent, occur in this district cutting the rocks of the Vancouver group, and are believed to be related to the Coast Range batholith. They are distributed throughout the district in the form of small batholiths, stocks, dykes, and occasionally in the form of sills. In the southern part these intrusions consist of two types distinctly different in composition and age; a diorite consisting of oligoclase to an desine plagioclase, little or

no quartz, and a relatively high proportion of hornblende and biotite; and a granodiorite consisting of orthoclase, oligoclase, quartz, and a relatively low proportion of ferromagnesian minerals, chiefly biotite. . . .

"In the northern part, however, these two types become so intimately intermixed that it is impossible to map them separately on the scale adopted. There is also a change in the colour of the rocks from light and dark greys to pinks and reds" (28, pages 13-16).[1]

The only geological maps of the west coast that have been published are those by Dawson (2) in 1886, showing the distribution of the formations from Quatsino sound to cape Scott, at the northwest extremity of the island; and by Clapp (17) in 1908-1910, showing the geology from the southeast shore of Barkley sound to Victoria. Of the intervening stretch of about 175 miles, no geological map is yet available.

GEOLOGICAL OCCURRENCE OF THE IRON DEPOSITS

Occurrences of iron ore minerals, principally magnetite, are common in the vicinity of the west coast of Vancouver island. As indicated above, these occurrences occupy a belt, roughly parallel to the coast, but inset a few miles from the outer margin of the island. They are frequently referred to as occurring in the older sedimentary and volcanic rocks, flanking on the southwest what is believed to be the igneous backbone or core of the island.

As outlined in the table on page 163 they occur as a variety of types, each with well-marked characteristics. With the exception of the limonite deposits, that are recent surface concentrations, all of the others are believed to be of contact metamorphic origin. Of the deposits of this origin, there are three principal sub-classes: (a) contact deposits in limestone, (b) contact deposits in volcanic rocks, and (c) contact deposits of copper sulphides and magnetite in volcanic rocks or limestone. In some cases, as listed, the original petrographic character of the host rock could not be deciphered, and these are listed under the heading of "Host rock of unknown origin". A small occurrence of hematite is also listed.

Contact metamorphic deposits in limestone (principally of the Nitinat formation?) produced by the intrusion of hornblende diorite (Beale formation) are more important as possible sources of iron ore than any other type, since their magnetite is more massive, of better quality, and is associated with less gangue. Many of the individual deposits show clean-cut boundaries with the limestone. They are usually unstratified, and the garnet-epidote parts are usually segregated.

The deposits in volcanic rocks (andesitic tuff and andesite of the Vancouver volcanics) are in some cases quite extensive, with respect to the distance the mineralizing solutions have wandered, but they are characterized by a bedding structure, inherited from the tuffs, in which discontinuous flat lenses of magnetite are interbanded with layers of silicates and gangue, with a consequent rarity of magnetite segregations. These deposits are also believed to owe their origin to intrusive masses of diorite.

The copper sulphide-magnetite group contains, in addition to magnetite, chalcopyrite and bornite, and occurs in both limestone and volcanic rocks. The individual deposits vary considerably in character, but they

[1] In this and all succeeding references, the number cited is that used to designate individual articles in the Bibliography, p. 158.

all show a development of copper minerals considerably later than that of magnetite. This is believed to be due to the fact that those parts of the coast where they occur are underlain by two intrusives, an older diorite and a younger granodiorite or granite; and the magnetite mineralization is believed to have been caused in large part by the influence of the diorite, whereas the copper mineralization is ascribed to the younger intrusive.

During the course of the investigation of the various contact deposits, some observations were necessarily made regarding the method of introduction of the magnetite from the intrusive into its host rock; but as the prime object of the survey was an estimation of tonnage based on geological facts and relationships, a systematic detailed study of these methods could not be undertaken.

As stated or implied in many places throughout this report, the magnetite is in all cases believed to have been introduced not as a magnetite magma by ore injection, but by a slow, gradual, progressive replacement of limestone, tuff, andesite, or diorite by tenuous solutions of considerable penetrability. This conclusion is stated here so as to give a background for the sections dealing with the ore genesis of each deposit; but the evidence for it is not included in a report of this character. It is the writer's hope to present in a separate paper at a somewhat later date his ideas regarding the replacements by these magnetite bodies.

Since their designation as contact metamorphic deposits will constitute one of the principal criteria by which the extent and mineralogical continuity of the individual deposits will be judged, it will be pertinent to indicate at this stage the nature and chief characteristics of contact metamorphic deposits in general. The following quotations from eminent authorities will suffice for this purpose. Lindgren[1] states that:

"In many geological provinces, granular igneous rocks, such as granite, diorite, and syenite, have broken through and invaded sedimentary rocks. . . . Along these contacts, bodies of useful minerals are often found, most commonly where the sedimentary rock is limestone, or, at least, calcareous.

"All the world over, this group presents certain characteristics, the more essential of which are the following:

"Form: The deposits generally follow the contact, but are extremely irregular in detail, and almost always very bunchy. No regular law has been recognized as governing the form of the ore-bodies, which are sometimes lenticular masses. . . .

"Constituent minerals: The gangue contains garnet, wollastonite, epidote . . . . amphibole, pyroxene . . . . vesuvianite, quartz, and calcite. . . . The ore minerals are specularite, magnetite, bornite, chalcopyrite, pyrite, pyrrhotite, and more rarely galena and zinc blende. . . . The characteristic feature is the association of the oxides of iron with sulphides."

Emmons[2] says that:

"Contact metamorphic deposits vary greatly in size. Many of the sulphide deposits are merely small concentrations of ore minerals in a gangue of heavy silicates, and the ore-body grades into the country rock

[1] Lindgren, W.: "The Character and Genesis of Certain Contact Deposits"; Trans. Am. Inst. Min. Eng., vol. 31, p. 227 (1901).

[2] Emmons, W. H.: "The Principles of Economic Geology"; New York, 1918, pp. 35-36.

by decrease in metallic minerals. . . . But other contact metamorphic deposits are large and have supplied ore for continuous mining operations extending over many years. The irregular character and erratic distribution of these deposits, however, make it necessary to observe caution in estimating ore reserves, and generally for blocking out ore the exposures of such deposits must be closer and more nearly continuous than those of sedimentary deposits or persistent veins. Iron oxide deposits of this class likewise show great variation in size. Several bodies of magnetite in the Philipsburg region, Montana, contained only a few thousand tons. On the other hand, the magnetite bodies that replace limestone at Cornwall, Pa., are extensive. Perhaps the most extensive deposits of contact metamorphic iron ore in the United States are those of Iron Springs, Utah, and the Eagle mountains, California."

Iron deposits of different character from these occur here and there near the west coast, but, with the exception of the limonite occurrences, they are of very small extent and of no importance. The tabulated statement given below shows the relative importance of the different geological types and the principal deposits belonging to each.

[*GEOLOGICAL CLASSIFICATION OF THE IRON DEPOSITS*

A. Contact Metamorphic Deposits

(1) MAGNETITE DEPOSITS. The principal mineral is magnetite, and in most cases the mineralizing intrusive is of the diorite clan.

(a) *Host is Limestone*

Conqueror, Sirdar, Little Bobs-Baden Powell } Bugaboo creek
Other Bugaboo Creek and Gordon River deposits
Harris creek, Port Renfrew
Sarita river, Barkley sound
Sunshine, Barkley sound
Defiance, Alberni canal
Magnetic, Henderson lake
Violet, Hesquiat lake
Stormont, Glengarry, Rob Roy, Prince Charlie } Nootka sound
Lord of the Isles No. 4, Barkley sound
Kennedy lake, Clayoquot sound

(b) *Host is Volcanic Tuff or Andesite*

Darby and Joan, Alberni canal
Copper island, Barkley sound
Black Prince No. 3, Barkley sound
Agnes, Hesquiat lake
June, Quatsino sound (in part)
Ingersoll river, Quatsino sound
Crown Prince No. 5, Barkley sound
Bald Eagle No. 2, Barkley sound

(c) *Host Doubtful, Due to Intense Metamorphism*

Iron Chief, Barkley sound
Beck's claim, Clayoquot sound

(2) COPPER-MAGNETITE DEPOSITS. Chalcopyrite and bornite are associated with magnetite in deposits of this class, and in most cases constitute the principal value.

Tidewater, Sydney inlet
Kokshittle arm, Kyuquot sound
June, Quatsino sound (in part)
Old Sport, Elk lake, Quatsino sound

(3) SPECULARITE DEPOSIT

Sunshine, Barkley sound (in part)

B. Limonite Deposits

West arm, Quatsino sound

C. Segregation or Shear-zone Deposits in Gabbro

Sooke peninsula

D. Beach Placers

Wreck Bay black sand deposits

SUMMARY OF THE DEPOSITS WITH TONNAGE ESTIMATES

In submitting the following estimate of available iron ore in the west coast deposits, it is hoped that the reader will bear in mind the following facts on which all the conclusions are based.

(1) *"Proved ore"* is used in the sense adopted by mining organizations, who may be contemplating the investment of capital in mining and treatment plants. By it is meant a body of ore that is exposed either by nature or by artificial development, or both, on three sides, to such an extent that there is no question of its actual existence.

(2) *"Probable ore"* is used partly in a commercial and partly in a geological sense, to mean ore whose existence is strongly indicated but not proved, in that it is not exposed on three sides. It applies particularly to the probable extension of exposed masses or ledges and is usually based on a generally accepted geological principle that in the average case a body of ore will continue in depth to a distance equal to at least half of its surface length.

(3) *"Possible ore"* is used to indicate a possible extension of exposed bodies beyond the limits of what is included in probable ore, and in some sense to include deposits that may not outcrop at the present surface. It is quite evident that calculations of tonnage founded on such a delicate basis of fact could not, and would not, be included by any reliable mining company in any valuation of a deposit, except in so far as they would affect its speculative value. It was found to be so difficult, indeed almost impossible, to establish the geological limits of what might be included under the term "possible ore," that in most cases, the writer has preferred to present figures for such a tonnage in terms of various assumed figures for depth or sidewise extension. For instance, the statement concerning possible ore may be made in this manner, namely, that for every 100 feet of additional depth with the same area of surface exposure, there would be included, say, 60,000 tons of ore. Such a statement gives a concept of magnitude to the deposit that is useful, but it does not signify an actual extension to 100 feet, nor does it indicate the geological possibilities of such an extension.

(4) The reason for the conservative basis of estimation outlined above is that the main deposits are of contact metamorphic origin; and it is a well-established geological fact that deposits of this type are extremely prone to be irregular, freakish, to change grade rapidly, to pinch or swell to a marked degree in short distances, and to be subject generally to a well-known set of idiosyncrasies.

A classification of the deposits from a commercial standpoint, with estimates of tonnage, is presented herewith. Their grading is based entirely on their value as possible iron ore producers.

I. Deposits of Promise

—	Proved ore	Probable ore	Possible ore
Stormont-Glengarry, Nootka sound	8,500	51,500	110,000

II. Deposits of Doubtful Promise

—	Proved ore	Probable ore	Possible ore
Conqueror, Bugaboo creek	8,000	16,000	No estimate possible
David, Bugaboo creek	.....	.....	No estimate possible
Sirdar, Bugaboo creek	10,000	9,825	76,250
Little Bobs-Baden Powell, Bugaboo creek	37,300	61,700	165,000
Sarita, Barkley sound	5,400	25,000	No estimate possible
Limonite, Quatsino sound	.....	.....	No estimate possible

III. Deposits of No Value (No Estimates Possible)

Elijah, Bugaboo creek
General French, Bugaboo creek
General Warren, Bugaboo creek
General White, Bugaboo creek
Gordon River deposits, Gordon river
Lord of the Isles, No. 4, Sechart peninsula, Barkley sound
Crown Prince No. 5, Sechart peninsula, Barkley sound
Iron Chief, Sechart peninsula, Barkley sound
Bald Eagle No. 2, Sechart peninsula, Barkley sound
Black Prince No. 3, Barkley sound
Sunshine, Barkley sound
Wreck Bay placers
Darby and Joan, Alberni canal
Defiance, Alberni canal
Magnetic No. 1, Henderson lake
Kennedy Lake deposits
Beck's claim, Matilda arm, Clayoquot sound
Tidewater mine, Sydney inlet
Agnes Nos. 1 and 2, Hesquiat lake
Violet, Hesquiat lake
Rob Roy-Prince Charlie, Nootka sound
Waterloo, Kyuquot sound
Ingersoll River deposits, Quatsino sound
June group, Quatsino sound

DESCRIPTION OF IRON DEPOSITS

VICTORIA MINING DIVISION

(45) East Sooke Peninsula

Deposits on this peninsula were not examined in detail by the writer, because of authentic reports of their relatively high content of pyrrhotite. The descriptions given below are quoted from previous investigators.

LOCATION

The deposits are located on lots 3, 79, and 83, along the eastern side of East Sooke peninsula, at short distances back from the beach, and at elevations of not more than 200 feet above sea-level.

HISTORY

These deposits were first mentioned by Dawson (3), in 1886, but no information was given as to their discovery. Carmichael (6) states in 1902 that they were "located some years ago by Mr. William Ralph." Kimball (5) mentions the occurrences in 1897, and says that a number of shallow excavations had previously been made on them. "In 1900 the Pacific Steel Company took a bond on several claims on lots 79 and 83, and did some development work, consisting chiefly of stripping and open-cuts at various points on the slope of a hill. . . . East of these claims, on lot 3, a short distance back from the beach . . . . an outcrop of pyrrhotite and magnetite was observed. A shaft has been sunk on the outcrop, and a tunnel driven into the hill, but it did not go through the surface soil. On the dump there was a pile of magnetite containing a notable percentage of pyrrhotite and some copper pyrites'' (6). Since 1902 there is no record of any work having been done on these deposits.

GEOLOGY

The rocks of East Sooke peninsula were examined by Clapp (17) in 1908-1910, and by Clapp (23) and Cooke (24) in 1912 and 1913. According to them, the main part of the peninsula is made up of post-Eocene olivine gabbro and associated rocks intrusive into the Upper Eocene Metchosin basalts, and overlain by the early Miocene Sooke sandstones and conglomerates.

MINERALIZATION

According to Clapp and Cook (23) these deposits are mixtures of pyrrhotite and magnetite with some chalcopyrite, and occur as irregular and lenticular bodies in shear zones in the Sooke gabbro. Their occurrence and localization are said to be due either to segregation from the molten gabbro, or to hydrothermal replacement of the gabbro in the shear zones.

ECONOMIC CONSIDERATION

These deposits are of no economic importance as sources of iron ore.

Bibliography

See page 158 for further details

(3) Dawson, G. M., p. 100
(5) Kimball, J. P., pp. 26-27
(6) Carmichael, H., pp. 220-221
(16) Lindeman, E., p. 9
(17) Clapp, C. H., pp. 174-180
(22) Whittier, W. H., p. 48
(23) Clapp, C. H., and Cooke, H. C., p. 324
(24) Cooke, H. C., p. 26
(29) Ann. Rept. 1904, pp. 254-255
Anon.: "Sooke Iron Mine"; B.C. Min. Rec., vol. II, pp. 32-34 (1896).

(46) Port San Juan

Port San Juan is an open roadstead directly exposed to the prevailing southwesterly winds. According to the British Columbia Pilot[1] "the port trends in a northeasterly direction for $3\frac{1}{2}$ miles, and is $1\frac{1}{4}$ miles wide, ter-

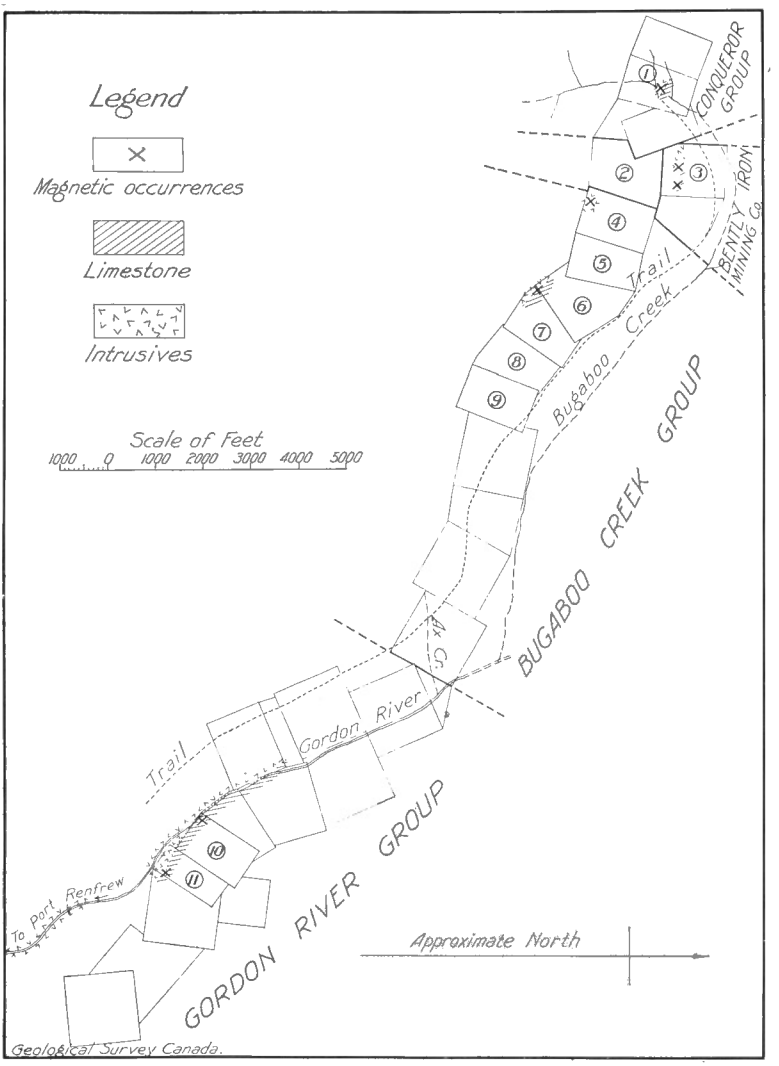

Figure 27. Magnetite occurrences, Bugaboo creek and Gordon river, Vancouver island, B.C. Mining claims referred to in text are indicated by numbers and are as follows: 1, Conqueror; 2, David; 3, Elijah; 4, Sirdar; 5, General White; 6, Baden-Powell; 7, Little Bobs; 8, General French; 9, General Warren; 10, Thorn; 11, Rose.

minating in a beach of muddy sand. Gordon river and Cooper inlet enter the port through this beach; very small coasters enter them towards high water, and find shelter therein. . . . . The port is open to

[1] British Columbia Pilot, vol. I, p. 29 (1923).

southwest winds, and a heavy sea rolls in when a moderate gale is blowing from that direction; and though it is possible that a vessel with good ground tackle would ride out a gale if anchored in the most sheltered part, it is by no means recommended to remain with any indication of such weather."

The shipment of ore in any considerable quantity from such an exposed port would require, therefore, the construction of tidewater loading facilities, of great strength and durability.

(46 a) Conqueror Deposit, Bugaboo Creek

(*See* Figure 28)

LOCATION

The Conqueror group of Crown-granted mineral claims, consisting of the Conqueror, Cyrus, Daniel, and Jennie Fractional, is located on both sides of Bugaboo creek (*See* Figure 27), a tributary of Gordon river, which enters Port San Juan opposite the town of Port Renfrew.

Fifteen or twenty years ago when the Conqueror and adjoining groups were being actively explored, there was an excellent pack trail for a distance of approximately 10 miles from the mouth of Gordon river to the most westerly of the workings, but today most of the trail, and particularly the lower 5 miles of it, is either obliterated or impassable.

The valleys of Gordon river and Bugaboo creek are in general neither deep nor precipitous, the water gradient is not steep (130 feet a mile), and timber is abundant on the valley slopes. The claims lie mainly on the smooth valley slopes of Bugaboo creek at elevations varying from 1,300 to 2,000 feet above sea-level. A thick mantle of glacial drift covers the country and supports a heavy growth of hemlock, balsam, spruce, and some cedar. Fallen timber and underbrush are thick in places, whereas in others there is little except moss covering the ground between the trees. Rock exposures are consequently few and intermittent, and the local topography does not give expression to any marked linear trend of formations. Here and there cliffs and bluffs of diorite, limestone, and magnetite protrude through the mat of vegetation, and these together with rock canyons in Bugaboo creek are the only indications of the character of the bedrock geology.

HISTORY AND OWNERSHIP

The deposits of magnetite on Bugaboo creek were originally staked by Robert Elliot, of Port Renfrew, in 1898, but the claims lapsed and four of them were re-located as the Conqueror group in 1899 and Crown-granted in 1905. The principal surviving owners are John W. McGregor, Harry Cathcart, and Thomas Parsell, of Victoria.[1]

GEOLOGY

Exploration on this group has been concentrated on the Conqueror claim where it is bisected by Bugaboo creek which falls 35 feet over a spectacular bluff of magnetite. The geological relations of the deposit are well exposed in the falls and rock canyon, but these exposures constitute little more than a vertical cross-section, as the rocks on both sides of the creek into which the deposit is believed to continue are concealed beneath a thick mantle of drift and vegetation.

[1] Personal communication from J. W. McGregor.

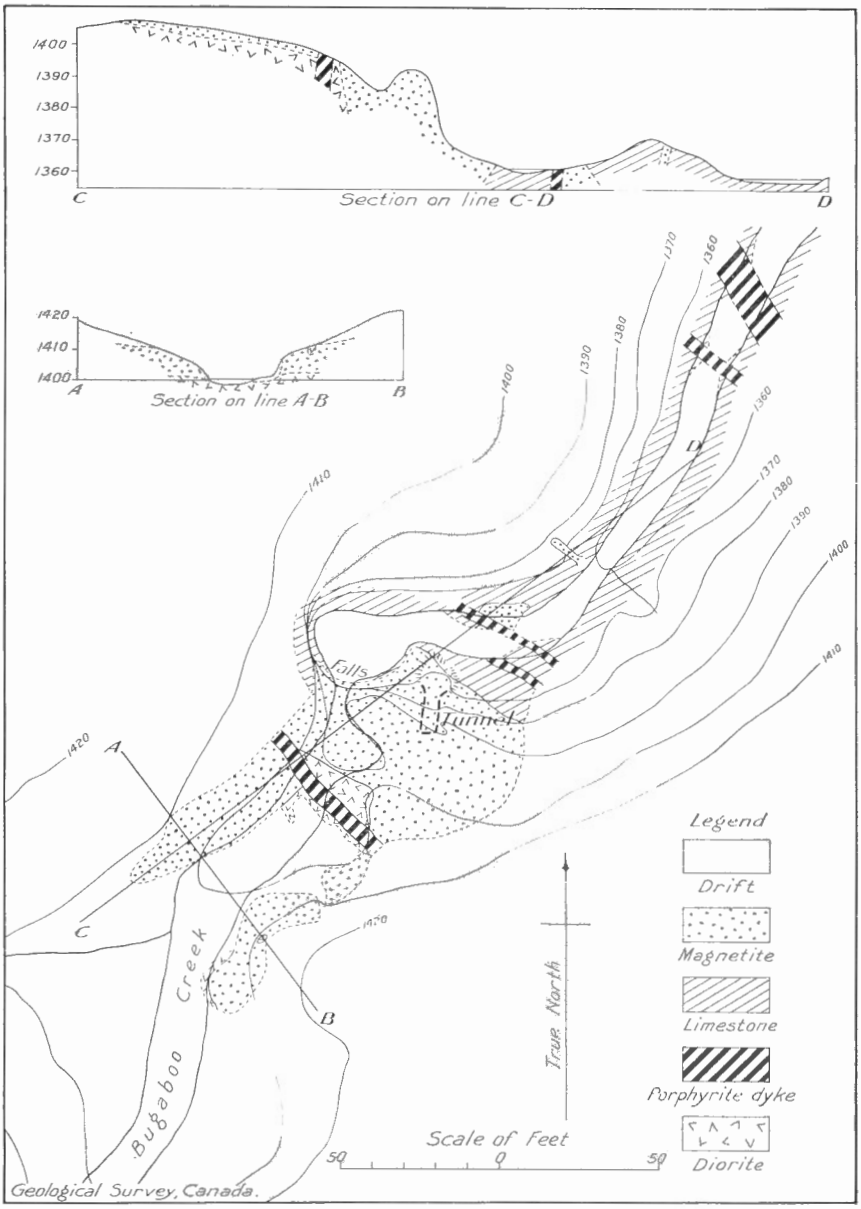

Figure 28. Magnetite deposit, Conqueror claim, Bugaboo creek, Vancouver island, B.C. Contour interval, 10 feet.

Below the falls (*See* Figure 28) the country rock for some distance is finely crystalline, bedded, grey limestone, dipping from 50 degrees to 60 degrees upstream, and cut by at least two diorite porphyrite dykes or sills. Above the falls, the exposures are inadequate, but the creek seems to flow on a basement of fine-grained, altered, and pyritized diorite, which is believed to be intrusive into the limestone. The contact between the two rocks is nearly flat-lying above the falls, changing to a very steeply dipping position underneath the falls (*See* Figure 28, section C-D). A 6-foot dyke of diorite porphyrite cuts in a northwesterly direction across the fine-grained diorite and the magnetite. This dyke is characterized by an abundance of lath-shaped plagioclase phenocrysts lying in parallel orientation with their direction of elongation nearly at right angles to the walls of the dyke, and producing a kind of fluxion structure dipping to the southeast. The dyke dips 80 degrees to 85 degrees to the southwest, and on both sides of it the fine-grained diorite and the magnetite are impregnated with considerable very fine-grained pyrite.

The contact zone of the diorite and the limestone in its limited exposure of about 75 feet trends about north 70 degrees west, which corresponds approximately with the general trend of formations in the district.

OCCURRENCE OF THE MAGNETITE

At least three separate bodies of magnetite occur in the small stretch of Bugaboo creek embraced within the area of the accompanying figure. The principal one, over which the creek falls, lies in the contact zone of the fine-grained diorite with the limestone, and for the most part within the limestone. This magnetite mass occupies a nearly vertical attitude at the falls, but laps over the fine-grained diorite above the falls like a blanket in nearly horizontal attitude. The creek has worn through this blanket, thus exposing the underlying diorite, and leaving two tail-like remnants of magnetite on each bank.

Below the falls are exposed two small masses of magnetite within the limestone, one of which is about 7 feet wide, and the other about $2\frac{1}{2}$ feet wide. The larger one is in the form of a pocket, lying against a dyke of porphyrite, and expanding somewhat in size in a downward direction. The smaller one is a tabular-shaped body with sharp walls against the limestone and standing nearly vertical.

From 300 to 400 feet southeast of the falls, on a heavily overgrown, nearly flat patch of country are two old open-cuts or pits 15 to 20 feet deep. The sides are badly caved at the present time, but several large pieces of magnetite, manifestly almost in place, were found in the bottom of one of them. These pits are situated along a line that represents closely the direction of continuation of the limestone-diorite contact; and this fact lends weight to the inference that the loose magnetite mentioned above is substantially in situ.

CHARACTER OF THE MAGNETITE

The magnetite is hard and of medium grain, and contains scattered through it varying amounts of garnet, epidote, and actinolite, either in small grains or small irregular-shaped masses. Pyrite and pyrrhotite occur sparingly within the magnetite, but pyrite is abundantly disseminated through the masses and blocks of diorite or contact silicates, included within the lode. Consequently it is expected that the sulphur content of the analyses quoted below is lower than that of any large tonnage of minable ore.

GENESIS OF THE DEPOSITS

This deposit is an excellent representative of the group described above as contact metamorphic deposits. The magnetite is a replacement of limestone, along its contact with fine-grained intrusive diorite; and possibly also to some extent a replacement of the somewhat shattered marginal parts of the diorite.

The actual contact of diorite and limestone cannot be observed at this locality, as the two rocks are separated by the tabular sheet of magnetite; but the localization of the magnetite in relatively abrupt contact with the diorite above the falls; its irregular width in the limestone, as shown by its pinching in a northwesterly direction; the occurrence of isolated lens-shaped or dyke-like bodies within the limestone; the garnetization of the diorite, and its impregnation with pyrite, pyrrhotite, and magnetite; the dissemination through the magnetite of grains and small bunches of the typical contact metamorphic calcium silicates, garnet, and epidote; and the fineness of grain of the diorite (a marginal phenomenon); all these facts bespeak a contact metamorphic origin for the deposit.

Clapp attributes the origin of this deposit to hot concentrated magnetite solutions, "virtually magnetite magma", that invaded and brecciated both the diorite and the limestone; and he states further that "irregular magnetite veins or apophyses extend from the magnetite body into the pure marble, brecciating it and including blocks of marble much as apophyses of an igneous rock would brecciate and include fragments of an invaded formation" (17, page 193). It is quite clear that masses of magnetite in the shape of dykes or sills occur in the limestone, and even surround blocks of limestone; but it is also true that massive limestone in places contains isolated solid masses of magnetite that could not have been formed by rapid injection of magma. Besides, there is no evidence to prove that the magnetite actually brecciated the limestone by its invasion, indeed, it is more probable, in the opinion of the writer, that the brecciation of the rocks was an accompaniment of the intrusion of the diorite, and that the magnetite solutions took advantage of the already existing or potentially existing channels, through the rocks, for their migration. It is contended that this deposit, as well as most of the others along the west coast of Vancouver island, does not owe its origin to magnetite magma that did its work by a process similar to igneous intrusion; but to hot tenuous iron solutions that had access to the country rock through pre-existent fractures, and accomplished their work by replacement rather than displacement.

ECONOMIC CONSIDERATIONS

Extent of Deposit

The greatest length of exposed magnetite parallel to the diorite-limestone contact is 75 feet; the width of the nearly vertical sheet varies from 45 to 60 feet. The two tail-like extensions running to the southwest constitute what seems to be remnants of what was a nearly flat blanket of magnetite overlying the intrusive diorite. The greatest thickness of magnetite exposed now in these flat masses is 9 feet. Brewer (21, page 15) quotes 100 feet as the maximum width exposed in the bed of the creek, whereas Lindeman (16, page 11) cites 63 feet which, according to the map and sections accompanying the present report, is very nearly correct.

There is a total vertical extent of magnetite exposed, without taking into account the "tails", of 40 feet, whereas at the site of the falls there is seen a height of magnetite of 20 feet.

Where the deposit disappears under the drift on the southeast bank of the creek, it shows a width of nearly solid mineral (considering the vertical tabular body only) of 58 feet. On the opposite side of the creek, the corresponding width is 24 feet, so that in a total length along the strike of 50 feet the magnetite pinches from 58 to 24 feet. This change in width within short distances is one of the most striking characteristics of contact metamorphic deposits.

There is nothing to prove or disprove the continuation of the deposit in a northwesterly direction from the falls, but if the decrease in width mentioned above were to continue the lode would disappear completely in an additonal 35 feet of length. On the other hand, magnetite is believed to have been found in the bottom of the old open-cut about 330 feet southeast of the falls, or 250 feet distant from the most southeasterly exposure in the creek bank. As the diorite-limestone contact trends in this direction, it is possible either that the same deposit continues for that distance, or that another one along the same contact occurs in the open-cut. From the nature of these deposits it is to be expected that each one should not necessarily be very long, but that a number of them, perhaps lenticular in shape, should be strung out intermittently along the contact.

It is justifiable to conclude that the statements above made regarding surface extent will equally well apply to the extent and shape of the body or bodies in vertical cross-section.

Analyses

No attempt was made to sample the deposit during the course of the present investigation. There were available a large number of analyses of samples taken in various ways and by various engineers from the Conqueror deposit, and these were considered sufficient for the purpose of indicating the tenor of the ore with respect to deleterious impurities. Analyses of large scale samples would alone give the much needed missing information.

The following selected analyses are typical of many that have been published.

—	A	B	C	D	E	F	G
Iron	69·06	68·50	69·50	59·7	67·09	69·2	65·98
Silica	1·40	2·25	.....	6·16	4·51	2·7	5·32
Sulphur	0·30	0·35	0·30	3·08	1·60	0·5	0·445
Phosphorus	0·06	0·05	0·06	nil	0·009	.....	0·012
Titanium	nil	nil	nil	.....	.....	.....	nil

A. Atkinson, J. B.: private report, 1904; composite of samples taken from sides, roof, floor, and face of tunnel.
B. Ditto: composite of samples taken across magnetite lead in limestone.
C. Ditto: composite of samples from different open-cuts on eastern bank of creek, and 75 feet above it.
D. Brewer, W. M.: Bibliography, No. 21; location of sample not specified.
E. Lindeman, E.: Bibliography, No. 16; sample taken along the tunnel.
F. Carmichael, H.: Bibliography, No. 6; location of sample not specified.
G. Yawkey, W. H.: private report, 1904.

The writer is quite certain that these analyses do not represent the average grade of the entire lode, which would of necessity be lower in iron and higher in insoluble constituents, but it is interesting to note from these figures that the magnetite is free of titanium, and well below the Bessemer limit in sulphur and phosphorus. It is a fact that the inclusion of masses of gangue, as would be the case in the mining of the deposit, would quite noticeably augment the sulphur content, but not the percentage of phosphorus. It should also be noted, that samples taken from near the surface would likely have undergone sufficient leaching to lower to some degree their sulphur content.

Development

Nature has done more to develop this deposit than has man. Bugaboo creek, by its erosive power, cut through the blanket deposit and exposed its bottom; and developed a vertical showing of 40 feet within the canyon. A tunnel, 14 feet long, in solid magnetite, driven from a point 8 feet above water-level, and the two old open-cuts referred to are the only openings made by man that the deposit shows today.

Tonnage Estimate

With the small amount of development that has been accomplished on this deposit, it is scarcely safe to attempt to estimate tonnage of ore; but in order to make the size of this deposit to some degree concrete, the accompanying figures are offered, and the data are given on which they are based.

Proved Ore: Ore contained within the boundaries of the exposures, to a depth of 6½ feet in the "tails" and an average depth of 20 feet in the main mass (at 8 cub. ft. per ton) = 8,000 tons.

Probable Ore: Ore that represents an extension of 25 feet lengthwise and downward beyond the boundaries of the block included as proved ore (at 8 cub. ft. per ton) = 16,000 tons.

Possible Ore: There is not sufficient data available to permit of any worth-while estimate of possible ore.

Value of Conqueror Deposit

This deposit is too small to be of any commercial value by itself, but it should be considered in its relation to the value of the group of magnetite deposits along Bugaboo creek.

Bibliography

See page 158 for further details

6. Carmichael, H., pp. 219-220.
16. Lindeman, E., p. 11.
17. Clapp, C. H., pp. 189-193.
20. Lindeman, E., and Bolton, L. L., pp. 5-6.
21. Brewer, W. M., pp. 15-16.
22. Whittier, W. H.
29. Ann. Rept., 1904; Ann. Rept., 1905, p. 216.

(46 b) David Deposit

LOCATION

The David claim adjoins the Conqueror group on the east, and the showings are located 1,600 feet due southeast of the falls on Bugaboo creek. The old trail to them has been obliterated. The country is in general similar to that on the Conqueror, except that it has a steeper slope towards Bugaboo creek. The deposit lies on the side hill at elevations between 1,400 and 1,600 feet (barometric) above sea-level.

HISTORY AND OWNERSHIP

The David mineral claim was located in 1901 and Crown-granted in 1906. The principal owners are J. W. McGregor, Harry Maynard, James Baker, and L. H. Anderson, of Victoria, B.C.[1]

GEOLOGY

The principal showings on this claim are near its southwest corner, about 1,600 feet due southwest of the falls on the Conqueror, and from 200 to 500 feet south of a line joining the Conqueror and Little Bobs-Baden Powell deposits (*See* Figure 27). The claim covers the northwesterly facing slope of a prominent ridge on which is also situated the Sirdar deposit. Near the southeastern corner of the claim are steep bluffs of diorite, similar to those near the Sirdar, but towards the centre of the southern part of the claim, and in the vicinity of the workings, the country flattens to some degree and drift-covered slopes mantled with thick timber lead down to Bugaboo creek.

Rock exposures are not sufficiently abundant in the proximity of the deposit to reveal clearly the bedrock relations. The only nearby exposures are in the trenches and pits and the only rocks now revealed are diorite and a highly metamorphosed variety consisting of epidote and actinolite. From the location of the deposit in the belt of country comprising the Conqueror, Sirdar, and Little Bobs-Baden Powell, and from the location of a diorite-limestone contact a few hundred feet distant, it is probable that similar rock relations occur here.

OCCURRENCE OF THE MAGNETITE

There is a dearth of information regarding the character of the magnetite occurrences on this claim, both in the literature of the past twenty years and as revealed on the ground today. Lindeman (16, page 11) states that "within a distance of 400 feet along a slope some strippings have exposed a good magnetite in several places, but do not give sufficient information to warrant an estimate of ore." Brewer (21, page 16) states that "open-cuts have been made in several places, exposing magnetite of approximately the same grade" as at the Conqueror. These constitute the only statements regarding the deposit on the David claim that could be found in the literature.

Magnetite is exposed today in a series of pits and trenches running nearly parallel to the west line of the claim and extending in a north and south direction for 235 feet. The walls of these workings are badly caved,

[1] Personal communication from J. W. McGregor.

so that only very incomplete data can be obtained regarding the nature of the occurrence. The most southerly exposure occurs in a trench and consists of a band about 16 inches wide with 3 to 4 feet of garnet-epidote rock on each side and some altered diorite a little farther to the east. The next exposure is in a shallow stripping 180 feet to the north on the side of a low bluff where a mass of magnetite 3 feet wide and extending 8 feet uphill is seen. After an interval of 10 feet of drift-covered ground there is another shallow stripping exposing magnetite 10 feet long by 10 feet wide. At this locality the magnetite is medium-grained, markedly sheeted, and free from silicates and sulphides. There are two other small strippings, 12 feet and 24 feet to the north of the last mentioned, and they also expose about 16 and 32 square feet respectively of magnetite, partly mixed with silicates, but relatively free from sulphides.

ECONOMIC CONSIDERATIONS

There is not sufficient exploration on the David deposit to permit of any estimate of the tonnage or of possible value. Magnetite is exposed in five isolated patches in an horizontal north and south distance of 235 feet, but there is no indication that it is continuous between these patches. Magnetite has here the tendency to stand in relief and produce small bumps penetrating the drift, thus leading to discovery; but between these bumps is lower ground indicating that it is underlain by rock rather than magnetite.

The main point of possible economic significance for this deposit is its location very close to a line joining the Conqueror and Little Bobs-Baden Powell workings.

Bibliography

See page 158 for further details

16. Lindeman, E., p. 11.
20. Lindeman, E., and Bolton, L. L., p. 6.
21. Brewer, W. M., p. 16.

(46 c) Elijah Deposit

LOCATION

The showings on the Elijah mineral claim are about 1,500 feet due north of those on the David, or 1,700 feet east of those on the Conqueror. There is no trail to them, but they are only a short distance away from the main Bugaboo Creek trail.

The surrounding country is similar to that at the Conqueror and David deposits. It is on the slope to Bugaboo creek, and bluffs of diorite and limestone interrupt the otherwise even hill slopes.

HISTORY AND OWNERSHIP

The Elijah and Benjamin Fraction were located in 1903 by J. W. McGregor and John Bently and Crown-granted in 1906. They now belong to the Bently Iron Mining Company, 1130 Summit ave., Victoria, B.C.[1]

[1]Personal communication from J. W. McGregor.

GEOLOGY

The chief exposures on this claim are along the location line, about 300 feet from the south line at an altitude of about 1,300 feet. Rock exposures consist of diorite and limestone, and a very marked contact between them crosses the location line obliquely, about 500 feet from the western boundary of the claim. The contact trends northwesterly with steep diorite bluffs exposed on its southwest side and a belt of limestone, 300 to 400 feet wide, occurring on the northeast side. With the exception of the exposures in the vicinity of the location line, the claim is generally covered with drift.

OCCURRENCE OF THE MAGNETITE

Immediately at a vertical contact of the diorite and limestone and lying between bands of contact metamorphosed rock, is the most westerly body of magnetite. It is low-grade material, mixed with rock and impregnated with pyrite, and has a width of 6 feet and a length up and down hill of 16 feet. Below this a small open-cut had been made which appeared to have yielded a slightly better grade of magnetite, but this is now caved. The contact was traced up and down hill for a distance of 300 feet, but with the exception of the outcrop described it appeared to be barren.

For a distance of 350 feet east of this contact limestone is exposed in steep bluffs up to 175 feet in height. There a small tongue of diorite intrudes the limestone, and two other masses of magnetite are found in close proximity to it. One of these occurs in a vertical exposure 25 feet high and 20 feet wide, surrounded by drift; the other, 15 feet to the west of it, shows a width of 10 feet and a length of 12 feet measured along a slope of 65 degrees. It is also surrounded by drift. About 6 feet below this outcrop is an exposure, 15 feet in diameter, of garnet and quartz, cut by a fine-grained rock resembling a diorite. A small tunnel, now caved, had at one time been driven below this exposure.

The last two exposures of magnetite are of good quality, fine- to medium-grained, with a small amount of disseminated garnet and tremolite, and almost entirely free from sulphides.

ECONOMIC CONSIDERATIONS

These deposits do not appear to be of any value, at least as far as present information goes. They admit of no tonnage estimate. They are somewhat off the trend of the mineralized zone passing through the Little Bobs-Baden Powell, Sirdar, and Conqueror.

(46 d-g) Bugaboo Creek Group, Bugaboo Creek

LOCATION

The Bugaboo Creek group of Crown-granted mineral claims is located along the south side of Bugaboo creek, and extends from the David claim downstream to the vicinity of the junction of Bugaboo creek with Gordon river. There are two claims in the group, named as follows, beginning with the most westerly: Sirdar, General White, Baden Powell, Little Bobs, General French, General Warren, Tax, A. Fraction, A. Wax. They are disposed in a northwesterly to westerly trending line 2 miles in length paralleling what is believed to be the strike of the limestone belts in which they occur (Figure 27).

These claims are reached by the same route as that described for the Conqueror, and the old trail to the Conqueror traverses the Bugaboo Creek group from end to end. The main workings are located well above and to the south of the trail, and may be reached along two almost obliterated zigzag trails up the mountain side. The group is, as an average, about 2 miles closer to Port San Juan than the Conqueror group.

The main showings of the group, on the Sirdar, Little Bobs, Baden-Powell, General French, and General White claims, are located at elevations varying from 1,300 to 1,700 feet above sea-level, and lie on the steep northeasterly sloping mountain side leading down to Bugaboo creek. The country is very similar to that in the vicinity of the Conqueror group, and is overlain in many places with a thick mantle of glacial drift. Timber, standing and fallen, and underbrush, are abundant, making the examination of the claims and their exploration difficult.

HISTORY AND OWNERSHIP

These claims were located in 1900 by Kirkpatrick brothers and J. Williams[1] and were later sold to the Gordon River Iron Ore Company. They are now controlled by the Godman estate, whose agents are Edwards and Ames, Pacific building, Vancouver, B.C.

The principal stripping, open-cutting, and the driving of the tunnel were done between 1900 and 1907.

(46 d) Sirdar Claim

(*See* Figure 29)

GEOLOGY

The Sirdar deposit of magnetite is located near the south line of the Sirdar claim, and about 300 feet from the southwest corner. In a straight line, running west-northwest, it is distant 2,800 feet from the falls on the Conqueror claim; and lies between elevations of 1,600 and 1,660 feet above sea-level. It lies on a thinly wooded slope facing northeasterly and leading down to Bugaboo creek. The mass of magnetite constitutes a bold bluff-like hammock on the otherwise uniform slope, and is covered over with a thin veneer of moss and some drift. A few, small, scrubby evergreens are also found and these have probably grown during the period of twenty years since the development ceased.

There are four types of rocks exposed in the immediate vicinity, namely, quartz, diorite, dykes of hornblende porphyrite and lamprophyre, and residual fragments of unreplaced crystalline limestone within the magnetite. Quartz diorite porphyrite of intermediate grain, consisting of phenocrysts of andesine in a quartz-feldspar mosaic, with minor amounts of orthoclase, hornblende, biotite, and magnetite, constitutes the country rock of the deposit. It may be observed in intermittent exposures along all contacts of the magnetite, and outcrops in prominent cliffs 80 feet to the south of the deposit, and close to its eastern edge. It also occurs at the portal of the tunnel, and in two belts within the tunnel, from the 62 to the 72-foot points, and from the 84-foot point to the face, a distance of 19 feet. Dykes of hornblende porphyrite and lamprophyre occur near

[1] Personal communication from J. W. McGregor, Victoria.

the southeastern extremity of the deposit, with relations suggesting that they have cut through the magnetite.

Limestone does not outcrop in the vicinity of the deposit. In the tunnel, however, many angular fragments of crystalline limestone are seen entirely enclosed by magnetite, indicating that they are unreplaced blocks of what was originally a large lenticular mass or inclusion of limestone in the quartz diorite porphyrite. Xenoliths of altered limestone also occur in the intrusive.

OCCURRENCE OF THE MAGNETITE

The magnetite occurs as a massive deposit almost completely surrounded by quartz diorite porphyrite. It has a maximum extension in a northwesterly direction of 125 feet, a maximum width in a northeasterly direction of 90 feet, and a proved depth of 50 feet to the level of the tunnel. The attitude of the deposit is in doubt on account of the paucity of structural data. At the mouth of the tunnel, and at a point along the lower contact about 60 feet west of the portal, quartz diorite porphyrite is in contact with the magnetite along a surface dipping 60 degrees to the north and northeast. The other observed contacts are more irregular than this one and neither substantiate nor disprove this structure. The upper edge of the lode along the line of section could not be found in exposed contact with the intrusive, but from the areal distribution shown on Figure 29, it can be seen that this boundary would not likely be very far to the southwest of the indicated contact of the magnetite with the drift. In addition, the face of the tunnel is without much doubt a distance of 19 feet within the main mass of the intrusive; and a line joining the innermost edge of magnetite in the tunnel with a point on the surface a few feet southwest of the margin of the exposed magnetite, would show a dip of about 70 degrees to the northeast. The conformability of this dip on the southwest margin of the lode with the 60 degrees dip of the northeast edge lends weight to the suggestion of a general northeasterly dip for the entire deposit.

The section through the tunnel shows, as mentioned above, a 10-foot band of quartz diorite porphyrite that appears to cut through the magnetite. The contacts of this intrusive are not well-defined and there appear to be gradations between it and the magnetite on either side. There is nothing to prove that this is a dyke of later date than the magnetite. On the other hand, the data point to the inference that the quartz diorite porphyrite band is a dyke that penetrated the pre-existent limestone mass, and that subsequent mineralization by magnetite both within the limestone and the dyke obscured the actual contact. No body of intrusive that might represent the continuation of this dyke in the tunnel was found within the mass of magnetite on the surface. It is quite possible, however, that surface mapping failed to reveal the occurrence of such a dyke, as the magnetite is in places covered over with moss, light shrubbery, and some drift.

It seems quite clear that the Sirdar magnetite is an almost complete replacement of a thick, short, lenticular mass of crystalline limestone, caught up in the main intrusive body. It differs, therefore, from the Conqueror deposit in that it is not a mineralization of limestone along one intrusive contact of a fairly large roof pendant, but a replacement of a smaller inclusion of limestone from both opposite intrusive contacts.

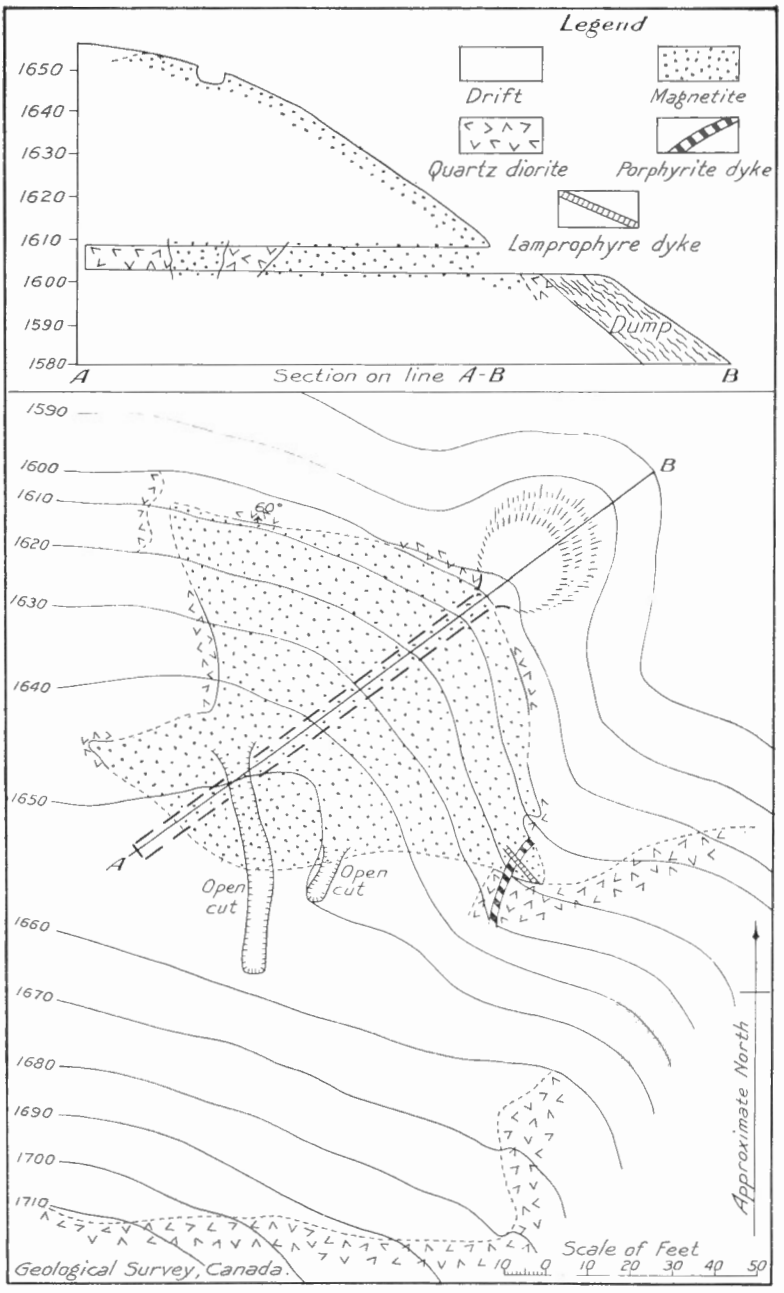

Figure 29. Magnetite deposit, Sirdar claim, Bugaboo creek, Vancouver island, B.C. Contour interval, 10 feet.

The Sirdar, therefore, has the character of an isolated replacement within the intrusive, the principal contact of quartz diorite porphyrite and limestone, corresponding to that at the Conqueror, being situated in all probability some distance to the north. Limestone cliffs, and a general limestone country may be observed along the trail leading from the Bugaboo Creek trail to the Sirdar.

CHARACTER OF THE MAGNETITE

The magnetite is a hard, dense variety, but it is not contaminated to any marked degree with bunches of contact metamorphic minerals. The entire outcrop, however, is quite rusty, and in the tunnel, where surface leaching has been insignificant, considerable pyrite is seen to occur, both as disseminations scattered through the entire lode, and as veinlets cutting it. The section along the tunnel consists of:

	Feet
Quartz diorite porphyrite	0–2
Magnetite enclosing fragments of limestone and carrying disseminated pyrite	2–40
Magnetite with veinlets and disseminations of pyrite	40–53
Solid magnetite	53–62
Diorite with scattered pyrite	62–72
Magnetite with considerable disseminations of pyrite	72–84
Diorite	84–103

In some zones within the magnetite the pyrite content reaches a high percentage. The deposit as a whiole does not represent a high quality of magnetite.

DEVELOPMENT

The deposit is developed by two shallow trench-like open-cuts, as well as some old stripping now obscured by new growth, and a tunnel 103 feet long crosscutting the deposit, commencing at the lower edge of the magnetite and attaining a vertical depth of 53 feet at the face.

ECONOMIC CONSIDERATIONS

Extent of Deposit

The size of the deposit is clearly shown in Figure 29. The possibilities for horizontal extent beyond the mapped boundaries are very limited for the following reasons: (a) the lode can only continue uninterruptedly where the outcrop ends against drift, but these gateways are rather small except along the south margin where there is a drift contact nearly 100 feet in length. That the magnetite does not continue more than a few feet beyond this broken line is shown by the facts that the magnetite has weathered in relief and produced a bump on the surface, and that bedrock contacts running northwest and southeast are found at either end of this 100-foot drift contact and trend towards each other. (b) The northeastern and southwestern edges of the deposit are known accurately in the tunnel, 102 feet apart. This corresponds to an horizontal width of outcrop above the tunnel of 111 feet.

The possibilities for vertical extent are greater than for horizontal expansion, as the facts point to a dip of 60 degrees to 70 degrees below the tunnel level. As this is steeper than the slope of the hill-side, the topography could not influence the depth factor. Based on the shape of the body of magnetite in plan, it might be interpreted either as a pipe-like deposit or

a very short, thick lens. Since the deposit is clearly a replacement of an inclusion of limestone, the latter alternative is decidedly the more plausible of the two. Proceeding on the reasonable assumption that a body of such a shape and origin will not be deeper than it is long, one arrives at the figure of 125 feet as a plausible one for average depth. However, the factor of depth, depending as it does on the shape of the original block of limestone, may exceed this figure.

Analyses

As in the case of the Conqueror deposit, sampling was not done on the Sirdar. The following analysis is taken from the available literature, and is here introduced with its description, as giving some indication of the grade of the deposit. It is hardly probable that the entire body of magnetite outlined on the map would analyse as low in sulphur as the figure given herewith.

	A
Iron	56·57
Insoluble	8·52
Sulphur	2·75
Phosphorus	0·121

A. Lindeman, E.: Bibliography, No. 16. Average sample taken along the tunnel.

Tonnage Estimate

Insufficient development of the deposit prevents any reliable estimate of tonnage, but the following data are offered as indicating an approximation to the size of the body of magnetite.

Proved Ore: Ore included within the volume, having as the outline of its top surface the exposed margin of the deposit, as its southwest boundary, a 70 degrees-dipping contact, and as its bottom surfaces an inverted gable, the axis of which is the horizontal centre line of exposed ore in the tunnel. This volume is considered as two pyramids, base to base, with heights of 60 feet to the northwest and southeast extremities of the magnetite exposure, the area of the base being that of the magnetite shown in the cross-section through the tunnel. 2,000 (area of section in square feet) × 60 (height in feet) ÷ 3 (for volume of pyramid) × 2 (number of pyramids) ÷ 8 (cubic feet per ton) = 10,000 tons.

Probable Ore: Ore contained within the volume of an irregular prism with a dip of 60 degrees to 70 degrees, whose base is on the tunnel level with an area equal to the area of exposure of magnetite on the surface, less the figures for proved ore given above. 6,100 (square feet, area of base) × 26 (average height) ÷ 8 (cubic feet per ton) = 19,825 tons. 19,825 − 10,000 (proved ore) = 9,825 tons of probable ore.

Possible Ore: It is out of the question to give any worth-while estimate of possible ore. It might be stated, however, that for every 100 feet of depth with the area of present exposure of magnetite (6,100 square feet) there would be an additional 76,250 tons. This figure, or any extension vertically, is considered as highly speculative.

Value of Sirdar Deposit

Considered as a single isolated occurrence this deposit is of no economic value. It is more reasonable, however, to view the Sirdar deposit as one of a group of magnetite bodies situated along Bugaboo creek and to estimate its value from this standpoint (*See* page 177).

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See page 158 for further details

16. Lindeman, E., pp. 10-11.
20. Lindeman, E., and Bolton, L. L., p. 7.
21. Brewer, W. M., p. 15.
22. Whittier, W. H.

(46 e) Little Bobs and Baden Powell Claims

(*See* Figure 30)

GEOLOGY

The Little Bobs-Baden Powell deposit is located on the steep, northeasterly side of a mountain sloping down to Bugaboo creek (Figure 27). It is distant about 2,200 feet in a southeasterly direction from the Sirdar, and constitutes the most southeasterly of the principal deposits in the valley of Bugaboo creek. The magnetite forms a bold bluff between altitudes of 1,360 and 1,470 feet, on an otherwise tree-clad and drift-covered slope, and here, as elsewhere, the outlines of the deposit may be interpreted from the topography. Short, scrubby trees, underbush, moss, and thin patches of drift cover the deposit in places.

Limestone and quartz diorite are the only original rock types on the property, but they are not observed in actual contact (*See* Figure 30). Steep limestone cliffs occur close to the mouth of the No. 1 tunnel, 50 feet to the northeast of the exposed magnetite. Old blueprints of the property (not dated) show a contact between magnetite and limestone near the mouth of the lower (No. 1) tunnel, but this could not be verified because of the caved condition of the portal. Exposures of magnetite and of contact metamorphic limestone and quartz diorite occur on the surface in a zone intermediate between the unaltered intrusive and the cliffs of limestone. To the northwest of the deposit the hill-side is thickly timbered and covered with drift and no rock is exposed for some distance; to the southeast, the case is somewhat similar except that the ore-body stops, as far as surface exposures are concerned, where a narrow but sharply defined depression cuts obliquely across the hill-side at north 70 degrees west.

OCCURRENCE OF THE MAGNETITE

The body of magnetite, as outlined in exposure, is somewhat lenticular with a northwesterly trend. Its lower boundary is entirely a drift contact, and there is no surface data regarding the actual position of this bedrock contact except that it must be somewhere between the portals of the two tunnels. Its upper contact is fairly well-defined, where it lies against the quartz diorite along a line trending north 40 degrees west. At a point directly above tunnel No. 2, this upper contact of the magnetite may be clearly seen to dip 50 degrees into the hill or to the southwest. The section along line A-B points quite clearly to the conclusion that the deposit as a whole dips into the hill, since the end of the magnetite near the face of the No. 2 tunnel is farther into the hill in a southwesterly direction than the limit of exposure on the surface. The upper contact with the quartz diorite seems to be concave towards the northeast, suggesting that the lode was formed in an embayment along the boundary of the quartz diorite. The deposit is clearly of contact metamorphic origin, more closely allied to the Conqueror occurrence than to the Sirdar, since the

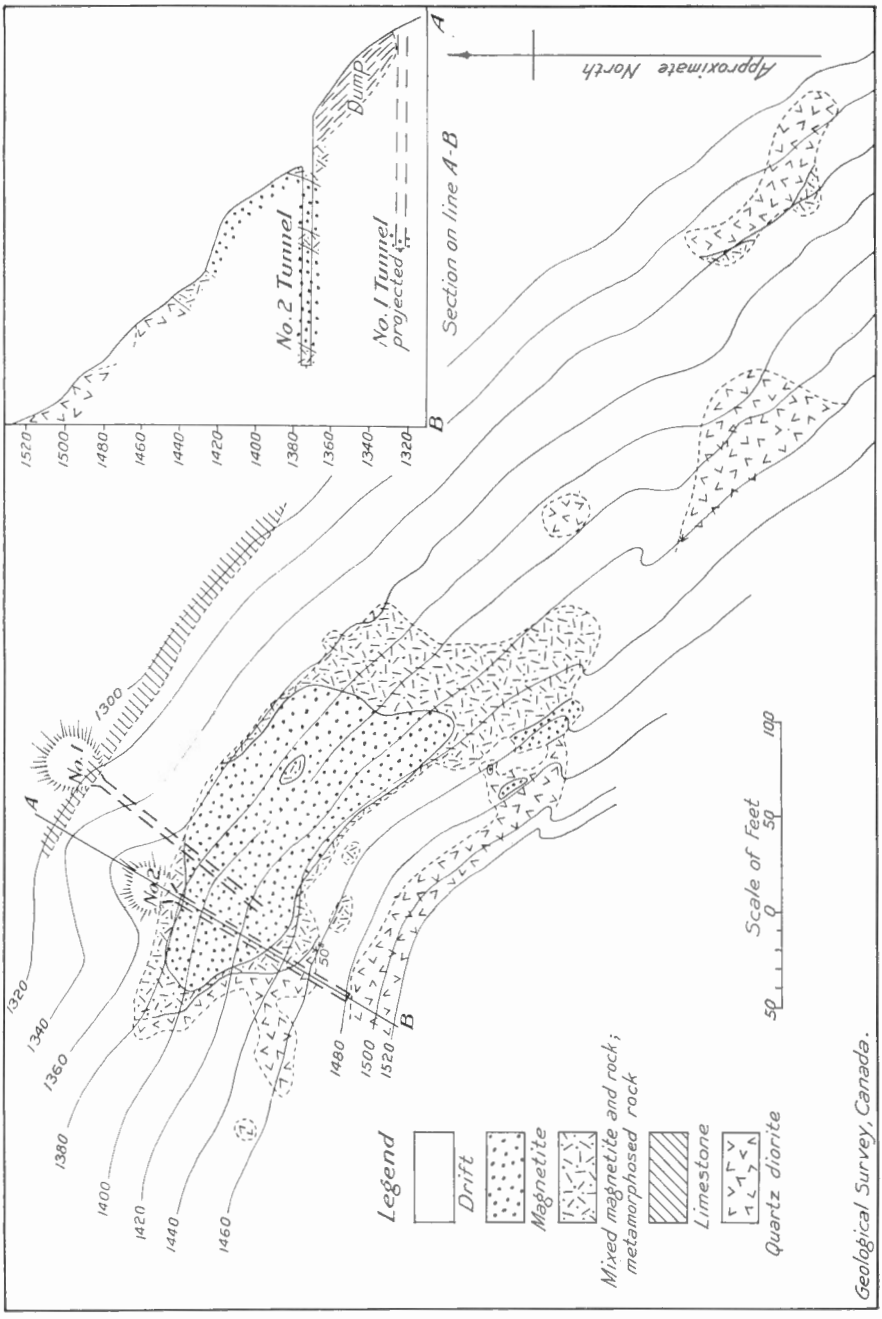


Figure 30. Magnetite deposit, Little Bobs-Baden Powell claims, Bugaboo creek, Vancouver island, B.C. Contour interval, 20 feet.

deposit is not enclosed on both sides by the intrusive. It is an alteration and a replacement of limestone by contributions of iron-bearing compounds from the crystallizing intrusive; and fragments of unreplaced limestone may be observed in the tunnel to be completely surrounded by magnetite. The magnetite may also be observed to occur to some extent within shattered parts of the quartz diorite, and in some places this rock is altered, as well as the limestone, to a group of typical contact silicates.

An attempt has been made to separate a mass of relatively solid magnetite from an encircling zone of mixed magnetite and highly metamorphosed rock. The aureole of mixed material contains less than 50 per cent of magnetite by volume. Within this are isolated patches of highly metamorphosed rock, either quartz diorite or limestone. They occur irregularly and presumably are the same as the zones of sheared and altered rock encountered by the tunnel.

The cross-section on line A-B through No. 2 tunnel illustrates the structure of the deposit insofar as it can be deciphered. The section is constructed from the field data obtained from the exposures and from No. 2 tunnel, combined with data taken from Lindeman's published report on his investigations of 1907. The course of the lower tunnel is not accurately known, since its portal is caved; and consequently its location on the map is approximate. The dump from the lower tunnel was examined carefully and was found to consist partly of magnetite, so there is every reason to credit its passing through a zone of that mineral. Regarding the geology of this tunnel Lindeman (16) states that it "had been run in the same direction (as No. 2 tunnel) for 114 feet into the hill, going through limestone and diorite. The last few feet, however, show magnetite, dipping in towards the hill."

CHARACTER OF THE MAGNETITE

Much of the magnetite in this deposit is impure, mixed with metamorphosed rock and impregnated with pyrite. A large part of the outcrop is rusty from the oxidation and hydration of the pyrite. The central part of the deposit, however, as outlined in the figure, contains only small quantities of pyrite and rock. The colour of this part of the exposure is dull black, with an absence of rusty stain, and the magnetite is coarser in grain. Broken, angular pieces of this magnetite show slickensided surfaces, and there is a bluish tone to their black colour. The detailed character of this body of magnetite may best be illustrated by quoting from the field notes the log of the upper (No. 2) tunnel, distances reading from zero at the portal:

Feet
0— 10: Decomposed rocky magnetite.
10— 14: Sand of garnet with little magnetite.
14— 28: Sheared magnetite with some sulphides.
28— 39: Good grade magnetite with small amount of sulphides.
39— 47: Band of altered silicates.
47— 58: Solid magnetite with considerable disseminated pyrite.
58— 68: Good grade magnetite.
68— 82: Solid lenses of magnetite with considerable sulphides. Some lenses are almost pure magnetite but are short, appearing only in one wall.
82—100: Fairly solid magnetite.
100—108: Sheared and mineralized contact silicates with veins and irregular bunches of magnetite.

There is no information available giving corresponding data for the lower (No. 1) tunnel.

DEVELOPMENT

The deposit is developed by two tunnels, 50 feet apart vertically, the one almost directly below the other, and a number of shallow open-cuts and strippings. The tunnels are driven at right angles to the longest dimension of the exposed ore, the upper one for a length of 108 feet, and the lower one for 114 feet. The portal of the latter is badly caved, making entry impossible. The old strippings are grown over with moss and underbrush, and many of the open-cuts are in a caved condition.

ECONOMIC CONSIDERATIONS

Extent of Deposit

The greatest longitudinal extent of the deposit is 320 feet and the greatest exposed width is 90 feet. The greatest proved depth is 150 feet from the highest outcrop to the level of No. 1 tunnel. The corresponding figures for the centrally outlined body of better quality magnetite are 200 feet, 70 feet, and 50 feet, respectively.

There are three possibilities for further extent of the deposit. (a) There is a possibility of an extension to the northwest beyond mapped boundaries, but there is no evidence suggesting or disproving this, except the absence of exposures. (b) There seems to be very little possibility for an extension to the southeast, as the three mapped exposures of quartz diorite appear to materially block the way. However, the ore zone might swing more directly towards the east and pass to the north of these exposures. In this connexion a statement may be quoted from a private report by Edwin Thomas (undated but probably previous to 1910) that "four hundred feet to the east of the natural outcrop the ore has been stripped and undergrowth and timber removed, exposing the vein for a distance of 75 feet in length and 40 to 50 feet in height." No indications of this exposure could be found by the writer. (c) Downward extension below the lower tunnel is probable for a few feet at least (to a depth equal to half the length of exposure), and possible to a much greater depth.

Analyses

Only two analyses of samples from this deposit are available, and they are quoted herewith. They manifestly represent the higher grade part of the deposit.

—	A	B
Iron	59·34	56·57
Insoluble	5·93	8·52
Sulphur	2·57	2·75
Phosphorus	0·012	0·121
Manganese oxide	1·14	.....

A. Thomas, Edwin: from tunnel No. 1.

B. Lindeman, E.: Bibliography, No. 16, taken along tunnel No. 2.

Tonnage Estimate

Proved Ore: The only part of the deposit that can in any sense be classified as proved ore (developed on three sides) is the double pyramid of magnetite, whose common base is the triangular section shown in the section on line A-B (Figure 30), and whose heights are represented by the lengths of the lines from this section to the two opposite ends of the exposure. 2,800 (square feet, area of triangular section) × 320 (feet, height of double pyramid) ÷ 3 (for volume of pyramid) ÷ 8 (for cubic feet per ton) = 37,300 tons.

Probable Ore: Included within a volume outlined by the present slope area of exposure, and a depth along the dip of 60 feet (to the breasts of the two tunnels), less the tonnage of proved ore. 13,200 (square feet, slope area of exposure) × 60 (feet, depth) ÷ 8 (cubic feet per ton) −37,300 (tons, proved ore) = 61,700 tons.

Possible Ore: No estimate can be made, but it might be stated approximately, that for every 100 feet of additional depth along the dip, below the limit of probable ore, with the same cross-sectional area as is exposed, there would be included 165,000 tons. This tonnage is not as speculative as the corresponding figures for the Sirdar deposit.

Value of Deposit

As far as can be judged from present exposure and development, the Little Bobs-Baden Powell deposit is not of sufficient magnitude to become by itself a commercial iron mine. Its economic possibilities, however, should be considered in its relation to the other Bugaboo Creek deposits (See below).

Bibliography

See page 158 for further details

6. Carmichael, H., p. 219.
16. Lindeman, E., p. 10.
17. Clapp, C. H., pp. 189-193.
20. Lindeman, E., and Bolton, L. L., p. 5.
21. Brewer, W. M., p. 14.
22. Whittier, W. H.

(46 f) General French and General Warren Claims

Magnetite occurs on these claims (*See* Figure 27), more particularly on the General French, about 1,200 feet east of the Baden Powell-Little Bobs deposit and 200 feet lower in elevation. No published or previously reported description of this occurrence is available. Present exposures reveal only a small deposit. Magnetite is exposed in a stripping showing a bluff of ore 20 feet high and 15 feet wide. The deposit is bounded on one side by crystalline limestone, and on the other by a mass of fine-grained diorite or andesite, which is in dyke form, having limestone on its other side. Considerable stripping had been done years ago around this occurrence, and a tunnel, now caved, had been driven into it. No magnetite float was visible above this exposure. The magnetite is of fairly good quality with only small amounts of intermixed pyrite.

(46 g) General White Claim

Along the trail leading from the main Bugaboo Creek trail to the Sirdar deposit, and at an elevation of about 1,540 feet, is a small open-cut, on the General White claim, exposing magnetite, occurring at the contact of a fine-grained diorite with crystalline limestone. The open-cut is badly caved, so that no idea can be obtained as to the width of the magnetite nor the trend of the deposit. The magnetite is fine-grained and slickensided, and as far as exposed is free from sulphides. It contains disseminations of greenish contact silicates and serpentine.

Economic Considerations Relating to the Bugaboo Creek Deposits as a Whole

As already intimated the belt of magnetite deposits in the Bugaboo Creek-Gordon River district may possess a value not attributable to any one of them by itself. The district in question is known to be underlain by a partly unroofed batholith of diorite (Beale diorite of Clapp (17)) in which are exposed many large and small roof pendants of limestone and volcanic rocks of the Vancouver group. Some of these pendants are quite small, whereas others are long and narrow, exhibiting the Cordilleran trend. The Sirdar deposit is a complete replacement by magnetite of one of the small roof pendants, whereas the Conqueror and Little Bobs-Baden Powell masses are replacements along one contact only of what are believed to be fairly large elongated roof pendants of limestone. The areal geological relationship between these iron deposits cannot be deciphered on account of the mantle of drift and thick cover of vegetation, but a detailed geological map of the area covered by the Crown-granted claims would assist materially in the solution of this problem. Contact deposits by their very nature are freakish and sporadic in occurrence, and they cannot be relied upon to persist for very long distances either along their strike or down their dip, as do true veins or mineralized shear zones. But they have the tendency to recur at intervals both vertically and horizontally along or near the contact of diorite and limestone. These intervals between deposits can only be determined by exploration. Along the southwest slope of Bugaboo Creek valley there are three well-exposed, partly developed magnetite deposits within a length of 1 mile along the Cordilleran trend—the Conqueror, Sirdar, and Little Bobs-Baden Powell—besides numerous other smaller, isolated outcrops. To the writer's mind, these deposits are manifestations of a bountiful supply of iron solutions originally in the crystallizing diorite, and constitute symptoms that may lead to the discovery in this belt at some future date of larger and more closely spaced lenses of solid magnetite. There is no conceivable geological reason why the tracing out of such contacts as are visible at the Conqueror and Little Bobs-Baden Powell deposits should not reveal other occurrences of similar types within the above-mentioned longitudinal extent of one mile.

This possibility constitutes, therefore, the principal item of economic interest in this belt of deposits at the present time. They are individually worth exploration if a market for the ore can be provided, but the distance from the coast, the comparative isolation of each deposit, and the small tonnage of proved ore that is available render the group of small immediate concern in the establishment of a new iron and steel industry.

(46 h-i) Gordon River Group, Gordon River

LOCATION

The Gordon River group of Crown-granted mineral claims is located along both sides of Gordon river, and extends from the Wax claim of the Bugaboo Creek group in a southeasterly downstream direction for a distance of about 2 miles (Figure 27). There are twelve claims in the group, named as follows, beginning with the most northwesterly: Max, Fizz, Gold Steel, Fizz Fraction, Pig Iron, Puffing Billy, Thorn, Rose, Jen, Rambler, Sophia. They are located along both sides of a diorite-limestone contact that follows closely the bed of Gordon river.

The main showings, which are on the Rose and the Thorn claims, are located about 5 miles from the mouth of Gordon river, and can only be reached now by the same route as that described above for the Bugaboo Creek deposits. The old trail is impassable for this distance, so that the present means of access is by dug-out canoe and back-packing.

Gordon river flows through the centre of this group, and where it traverses the lower claims it occupies a channel filled with boulders, that is from 200 to 300 feet wide. Above the Rose claim the river flows through a deep box canyon that is difficult to navigate even in a canoe. The exposures of magnetite are all close to the river, at elevations varying between 200 and 250 feet above sea-level. The highest outcrops are only about 50 feet above the level of Gordon river. The banks of the river are steeply sloping, thickly wooded, and densely covered with underbrush. All the areas that had been stripped and open-cut at the time of the operations are now covered with a network of fallen timber and a very dense growth of salal brush and salmon berry bushes, that made their mapping very arduous and inaccurate.

HISTORY AND OWNERSHIP

These claims were located in 1900 and 1901 and Crown-granted some five years later. Most of the development, including the sinking of the 300-foot shaft, with accompanying drifting, was done prior to 1903, under the direction of N. E. Newton, representing English interests. No work has been done since 1906.

The property was controlled by the Gordon River Iron Ore Company, and is now owned by the Godman estate, of which Edwards and Ames, Pacific building, Vancouver, are the agents.

(46 h) Rose Claim

The magnetite deposit on this claim is located on the northeast side of Gordon river, and 200 feet from the bank, almost on the line of junction with the Jen claim. The exposures are close to the bed of a small tributary creek. An old cable, for an aerial cage, crosses Gordon river at this locality, which is locally called No. 1 or Newton's mine.

The deposit is located in the proximity of a diorite-limestone contact that follows up the bed of Gordon river for about half a mile above this point. With the limited exposures in the immediate vicinity of the deposit, the rock relations could not definitely be deciphered. There is diorite, andesite (either a fine-grained phase of the diorite or a member of the Vancouver series of volcanics), and bluish-grey finely crystalline limestone.

There are two tunnels, each about 20 feet long, showing some magnetite, and a shaft, now full of water, but said to be 300 feet deep. The exposures are from 20 to 40 feet above the mean water-level of Gordon river, so that no development by tunnelling could be carried out.

The following data concerning the deposit and the geology in the shaft is from the report by Herbert Carmichael (6) in 1902, the only published description of the occurrence. "Close to the camp a shaft had been sunk about 300 feet, on a magnetite outcrop, which appeared to dip into the hill. At about 100 feet down this shaft a crosscut drift of 40 feet had been run to the north. This drift was not examined. It was reported by the foreman to be boarded up and all work had been suspended for the time at this point, but it was stated by the management that the drift had been run for about 40 feet, and had cut diagonally through about 18 feet of ore mixed with country rock. Similar drifts had been set off at the 200 and 300-foot levels, simultaneously, that at the 200-foot level being now in about 18 feet, and that at the 300-foot not so far. In neither of these drifts, nor in the shaft, was any ore visible, the rock driven through being chiefly diorite, though, of course, those drifts had not been driven far enough to strike the ore outcrop, should it continue to this depth at surface dip. The equipment consists of a one-drill Rand air compressor, and a small power hoist, both operated by steam."

This deposit is of no commercial value.

Bibliography

See page 158 for further details

6. Carmichael, H., p. 219.
7. Webster, A., pp. 61-62.
9. Anon., pp. 485-486.
21. Brewer, W. M., p. 14.
20. Lindeman, E., and Bolton, L. L., p. 6.
22. Whittier, W. H.
16. Lindeman, E., pp. 9-10.

(46 i) Thorn Claim

Magnetite is also exposed on this claim, at a distance of 1,400 feet northwest of the shaft on the Rose, and on the same side of Gordon river. The showings vary from 20 to 50 feet above the river, and extend from the bank to a point about 75 feet back from it. Here again the deposit occurs on a relatively flat bench, that was badly burned at one time, and is now a mass of reticulating fallen timber and dense underbrush. Rock types and relations immediately surrounding the magnetite are obscured by drift and vegetation, but it seems quite certain that the deposit occurs in the same contact zone between diorite and limestone as is found on the Rose claim.

There are three exposures—two smaller ones along the edge of the rock cliff overlooking the river, and one larger one, uncovered by stripping on top of the above-mentioned bench. The largest exposure is roughly triangular in shape with side dimensions of 80, 60, and 40 feet. Its thickness and attitude could not be ascertained. The smaller masses are veinlike stringers in limestone.

These showings, like those on the Rose claim, are of no economic value.

(46 j) Other Gordon River Deposits

Several minor deposits of magnetite have been found along and close to Gordon river, particularly along the lower parts of its course. Some of these are found along a ridge near Deakin's ranch about 2 miles from the mouth of the river; others are found and have been staked in the vicinity of Baden creek, a tributary of Gordon river.

None of these was sufficiently important to warrant detailed investigation, as little or no work has been done on them. They are not further described in this report.

(46 k) Harris Creek Deposits

LOCATION

Harris creek flows in a southerly direction and enters the westerly flowing San Juan river about 6 miles above its mouth, or about 15 miles from tidewater. Three claims are Crown-granted, numbered, 519, 520, and 521, and designated as follows: Tally Nos. 1, 2, and 3.

The deposits are difficult of access at the present time, as sufficient development had never been done on them to warrant the construction of a trail. From the mouth of Gordon river, a logging railway crosses to San Juan river and leads to a logging camp at the mouth of Harris creek. From this point the claims may be reached by a 9-mile traverse over a dilapidated trail, trap lines, and the bouldery bed of a creek.

The claims cover the north side of a steeply sloping hill at elevations of 1,200 to 1,900 feet above Harris creek, or 2,000 to 2,700 feet above sea-level. The hill-side is well timbered with cedar, Douglas fir, hemlock, and balsam.

HISTORY AND OWNERSHIP

The deposits were discovered previous to 1910, and were at that time owned by Messrs. Godman and Bentley. They have since reverted to the Provincial Government.

GEOLOGY

The country rocks are diorite in intrusive contact along irregular boundaries with crystalline limestone. In places the limestone was observed to be cut by tongues of diorite, which have here and there metamorphosed it to nearly solid garnet.

OCCURRENCE OF THE MAGNETITE

There is considerable magnetite float lying along the hill-side, and, in some cases, blocks of solid magnetite up to 2 or 3 feet in longest dimension were found. Magnetite mixed with contact silicates (garnet, epidote, etc.) and some pyrite is exposed on a face 10 feet high and 10 feet long, underlying limestone, near the southwest end of the boundary between claims 520 and 521. No body of solid magnetite in place could be found.

The summit of the hill was followed in an easterly and westerly direction for some distance, but the only exposures noticed were of limestone. Claim No. 521 was traversed by a series of sections, but the contacts of limestone and diorite observed were all barren except for the occurrence noted above.

The magnetite found as float was dense, black, free from impurities, and was of a much better grade than that observed in place.

GENESIS

The association of the magnetite with garnet and epidote in a country characterized by intrusive contacts of diorite with limestone, along with the garnetization of these contacts, indicates a contact metamorphic origin for the magnetite. It would, therefore, be expected to occur in irregular shaped masses of varying purity and extent at various places along such contacts.

ECONOMIC CONSIDERATIONS

The deposits have no value, as they stand today. Their occurrence in a zone that may possibly be a continuation of the zone of iron mineralization on Bugaboo creek may, however, make them of speculative interest, particularly since there is not sufficient work done on them to show even their local boundaries.

Bibliography

See page 158 for further details

14. Anon., p. 104.

ALBERNI MINING DIVISION

BARKLEY SOUND AND ALBERNI CANAL

Barkley sound, with Alberni canal at the head of it, is one of the great indentations of the west coast of Vancouver island. It is 16 miles wide at the entrance, about 16 miles long, and is roughly triangular in shape. It is abundantly studded with islands, arranged for the most part in two groups, and the spaces between them constitute the three main channels. Alberni canal extends inland in a northerly direction for 25 miles from the head of Barkley sound, to Port Alberni, and may be traversed for its entire length by sea-going vessels of deep draught. Excellent anchorages may be found at very many places within the sound and the canal, so that no hardships would be encountered in the shipment of ore.

Near Barkley sound and its tributary waterways, including Alberni canal, Uchucklesit harbour, and Henderson lake, are located the following deposits of magnetite: (a) Sarita River deposit, near Numukamis bay, (b) Copper or Tzartus Island deposit, (c) Sechart Peninsula deposits, between Effingham and Pipestem inlets, (d) Darby and Joan deposit at Smiths landing, Alberni canal, (e) Defiance group on Handy creek, Alberni canal, (f) Black Prince No. 3 and Sunshine group on Cascade creek, near Kildonan, Uchucklesit harbour, and (g) Magnetic No. 1 on Henderson lake.

(47 a) Sarita River Deposit

(*See* Figure 31)

LOCATION

The Sarita River group of Crown-granted mineral claims is located along the south shore of Sarita river about one mile from its mouth, and consists of the following locations: Black Bear, Union, Eureka, Southern Cross, United, Midday, and British Pacific. As far as can be ascertained, the magnetite deposit occurs on the Union and Black Bear claims or on adjoining land of the Indian Reserve, near the western end of a ridge, where it drops off sharply into the valley of a small creek tributary to Sarita river.

The deposit may be best reached by ascending Sarita river in a small boat at high tide for a distance of about one mile, to a point where a foot trail from the showings reaches the shore of the river. This trail is 600 yards long and follows the east bank of the small creek above mentioned to the base of the bluff of magnetite where the portal of the tunnel is located. Some years ago, there was a trail leading from the shore of Barkley sound, opposite Santa Maria island, overland to the Sarita deposit, but this trail is now impassable.

The country in which the deposit occurs is one of low, gentle slopes, heavily timbered with hemlock, balsam, and spruce, the interspaces being thickly clothed with salal, ground hemlock, and alder. A mantle of glacial drift covers the bedrock, in some places only as a thin veneer, but in others to a depth of several feet. Throughout the extent of the magnetite showings, however, the drift does not seem to average more than 5 or 6 feet deep.

The showings (*See* Figure 31) extend in an intermittent, crescent-shaped series of pits, open-cuts, trenches, and shallow shafts from the portal of the tunnel for 1,000 feet in an easterly direction, the convex side of the crescent facing the north. At the portal of the tunnel, which is the lowest point on the property, the elevation is only 30 feet (barometric) above sea-level; but this increases rapidly in a westerly direction up over the bluff of magnetite, to a plateau-like extent of ground with elevations of 130 to 160 feet; the highest magnetite outcrop on this plateau-like surface being 120 feet in elevation above the portal of the tunnel. The bluff of magnetite at the tunnel mouth rises vertically for 25 feet, and then the ground slopes up more gradually towards the west, attaining an elevation of 130 feet above sea-level in a lateral distance of 200 feet. There is no trail from the tunnel mouth to the other workings.

Sarita river, which drains Sarita lake, is a fine stream of water from 200 to 250 feet wide, and from 2 to 6 feet deep, with an average current of $1\frac{1}{2}$ to 2 miles per hour.

HISTORY AND OWNERSHIP

These deposits were staked prior to 1900 by a prospector named Logan who was engaged by the late William Wilson, of the firm of W. and J. Wilson, Government street, Victoria, B.C., and Captain John Irvine, who had been manager of the Canadian Pacific Navigation Company; and Logan retained an interest in the claims. About 1902, it was discovered that the Sarita magnetite deposits (or part of them) were on an Indian reserve, so that a lease was taken on the property. Both the claims and the leased ground were bonded to Homer Swaney, of Pennsylvania, who was expending a great deal of money in an investigation of the iron ore deposits of British Columbia, and who had recently purchased the Irondale blast furnace at Irondale, Washington, from the Puget Sound Iron Company. Swaney was drowned in a shipwreck near Victoria, and on the settlement of his estate, the Irondale furnace passed to the Moore Investment Company, of Seattle. Later the Moore Investment Company became bankrupt, and the iron deposits reverted to Wilson, Irvine, and Logan. Sometime afterwards, the lease was cancelled by the Indian Department on default of annual payments, but the mineral claims are owned by the Sarita and Copper Island Partnership, whose address is in care of W. Wilson, 1221 Government street, Victoria, B.C.[1]

[1] Memorandum from W. M. Brewer, 1925.

Most of the exploration, including the tunnel, was done prior to 1903, as geological sketches of the workings are given by Carmichael in 1902 (6, page 215).

In 1922, W. M. Brewer was called upon to furnish some iron ore for experimental purposes under the provisions of the "Iron-Ore Supply Act, 1919" and he secured about 10 tons from the old dumps at the entrance to the adit on this property. This ore was shipped to the Vancouver Engineering Works to be mixed with scrap iron and steel in their electric furnace operations.

GEOLOGY

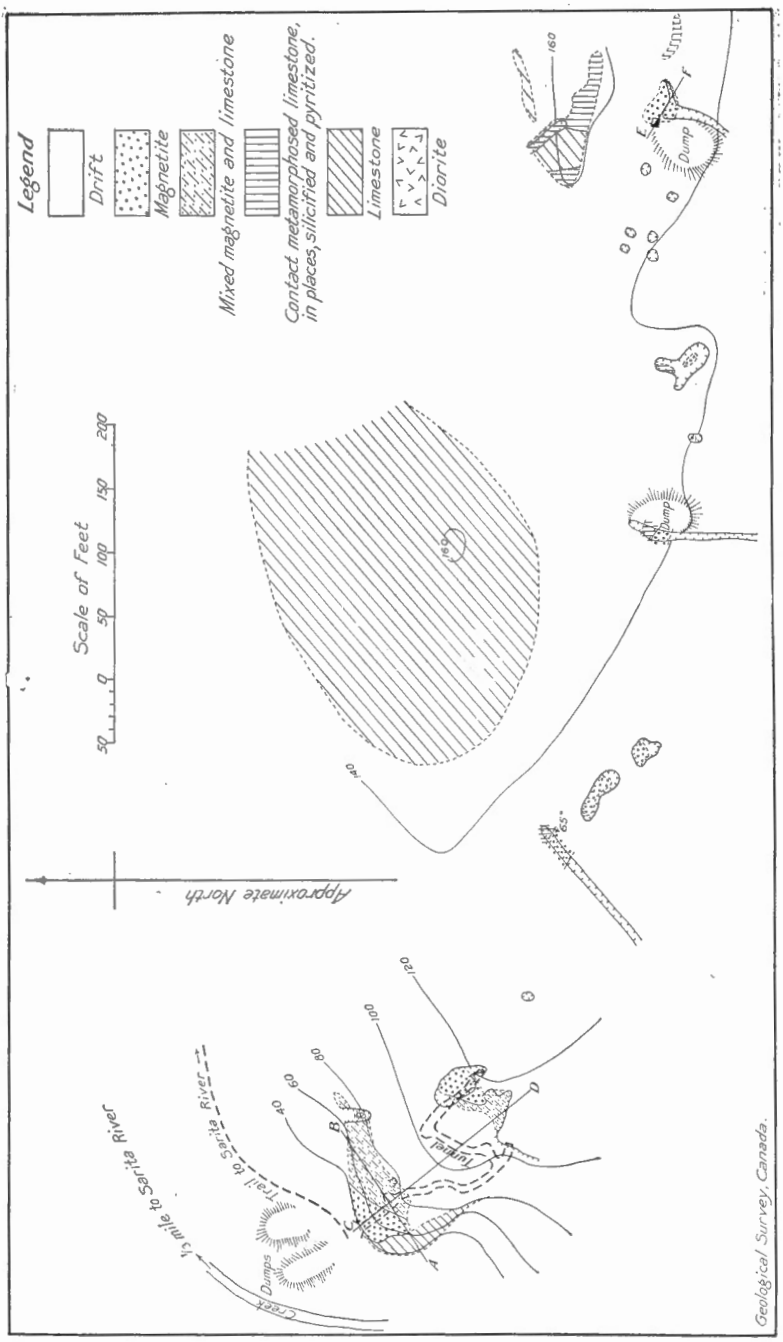
The deposit occurs within a country of white to grey limestone, intruded in places by hornblende diorite of the Beale formation. In only a few places are bedding structures visible in the limestone. One of these is at the bottom of the winze, 30 feet from the portal of the tunnel, where the stratification of the limestone is almost horizontal; and another is in the large central exposure of limestone, where indications also point to a general horizontal attitude or low angle of dip. The flatness of the boundaries of several magnetite exposures in limestone also points indirectly to the above conclusion.

Apart from one or two small surface exposures near the bluff at the western end of the deposit, no diorite is exposed at the surface, whereas on the other hand, the inner 75 feet of the tunnel is in solid hornblende diorite. This fact, combined with the distribution of the two rocks as shown on Figure 31, leads to the inference that the ridge on which the deposit occurs is underlain by a boss of diorite whose contact with the limestone undulates about the plane lying at a shallow depth below the surface. Garnetized limestone and solid masses of brown garnet occur in some places near the intrusive contact; in other places, silicified limestone with bountiful disseminations of pyrite occurs.

OCCURRENCE OF THE MAGNETITE

Magnetite occurs in solid masses of irregular shape, mainly within the limestone or associated with garnetized portions of it. In the tunnel, the lode is observed to occupy a position between diorite on the east and limestone on the west, and to have similar relations to those rocks as were exhibited by the magnetite deposits of Bugaboo creek. In no other part of the property is it seen in contact with diorite, but the presence within the magnetite of residual fragments of limestone, together with its occurrence in irregular-shaped masses in association with the characteristic contact silicates brands the lode as a contact deposit.

The irregular structure of the deposit may be illustrated by the following observed facts: (a) A few feet southwest of the portal of the tunnel, the magnetite is in sharp contact with a mass of limestone, the contact dipping to the northeast under the magnetite; (b) within the tunnel, the contact of diorite and magnetite dips southeasterly with the diorite on top of magnetite; (c) the innermost 30 feet of the tunnel is in diorite, but 75 feet above this on the surface is a stripping and open-cut exposing magnetite mixed with limestone, but no diorite; (d) the section on line E-F (Figure 31), shows a thickness of about 10 feet of magnetite lying with a nearly flat contact on top of limestone and its contact metamorphosed phase.


Legend
Drift
Magnetite
Mixed magnetite and limestone
Contact metamorphosed limestone, in places, silicified and pyritized.
Limestone
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Scale of Feet
50 0 50 100 150 200
Approximate North
Trail to Sarita River
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Dumps
Trail to Sarita River
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Dump
Geological Survey, Canada.

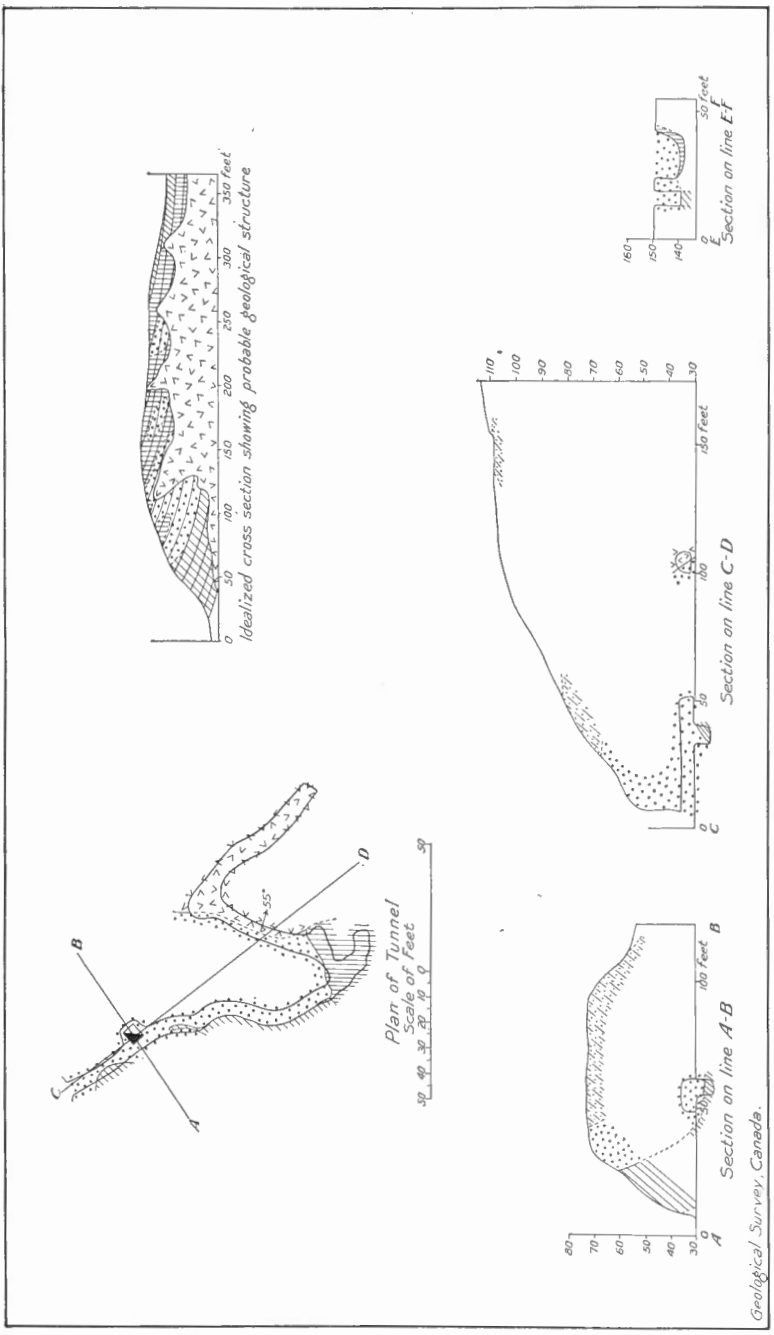

Figure 31. Magnetite deposit, Sarita river, Vancouver island, B.C. Contour interval, 20 feet.

The accompanying figure shows a belt of magnetite exposures in open-cuts, strippings, and a shallow shaft for a total length of 920 feet, but these are separated by intervals of drift varying in width from 25 to 180 feet. These artificial exposures show no relationship between magnetite and rock, nor between diorite and limestone. Since many of these are merely strippings, they afford very little information other than the surface extent of the magnetite, except in the case of one long trench where an ore layer may be observed to dip 65 degrees to the southwest. A marked impression is created that these exposures have little relationship to one another and that they are entirely unconnected. They seem to be the exposed parts of a series of irregular-shaped masses of magnetite whose principal extent is nearly horizontal rather than vertical.

An attempt has been made on Figure 31 to separate exposures of nearly solid magnetite from other areas characterized by magnetite bunches and stringers in limestone.

CHARACTER OF THE MAGNETITE

The magnetite in the bluff at the west end of the property, and within the tunnel, is a medium-grained, hard, dull black variety containing only a very small amount of visible sulphides. It is also to a large extent free from inclusions of silicates, but contains fragments of unreplaced limestone. Towards the east end of the showings, more pyrite is found in the magnetite, and there is a greater mixture with bunches of silicates. This may be due to the fact that in this part of the zone the individual masses of magnetite are smaller than towards the west.

ORIGIN OF THE DEPOSIT

The deposit is undoubtedly a partial replacement of a limestone inclusion or elongated roof pendant in the Beale diorite. The localization of the magnetite in the tunnel between diorite and limestone, as well as the development of the typical contact lime-alumina silicates, and the sporadic nature of the individual showings, prove the replacement to have taken place under contact metamorphic conditions.

ECONOMIC CONSIDERATIONS

Extent of Deposit

Exposures occur at intervals for a distance of 920 feet, but at no point except at the portal of the tunnel is a greater width than 40 feet of solid magnetite exposed. In the bluff at the west end of the deposit there is a width of about 60 feet of solid ore with an additional 20 or 30 feet of mixed limestone and magnetite. In all of these cases it is impossible to determine the direction, and consequently the amount of true width. Above the portal of the tunnel, there is continuously exposed a vertical height of 40 feet of magnetite; but with the exception of this and a 10-foot depth in the shallow shaft at the east end of the property, the greatest exposed depth is not over 2 or 3 feet.

Development

One tunnel, 295 feet long, at the level of the lowest exposure, a 10-foot shaft, about a dozen open-cuts, strippings, and trenches showing magnetite, and many others that do not, constitute the entire development of the deposit. The tunnel level exposes magnetite at a depth of 120 feet below the highest surface exposure. From a mining standpoint the deposit is handicapped by being located so close to sea-level as to prohibit much development by tunnelling methods.

Analyses

There are many analyses available in private reports and published literature, and these are here quoted for what they are worth. Most of them are taken from the bluff of magnetite at the west end or from the magnetite within the tunnel. It is reasonable to expect that surface leaching may have removed sulphur from this part of the deposit, making the analyses quoted lower in sulphur than the average for the deposit. No sampling was undertaken by the writer.

—	A	B	C	D	E	F	G	H	J	K
Iron	64·3	59·82	57·60	57·84	60·50	60·12	60·89	63·7	63·8	52·4
Insoluble	3·69	.....	.....	.....	.....	.....	3·81	.....	.....	.....
Silica	.....	5·59	6·00	6·70	2·94	3·40	.....	3·85	4·2	4·6
Sulphur	.....	1·68	4·85	2·41	0·44	0·10	0·76	0·3	0·55	0·2
Phosphorus	0·009	0·024	0·023	0·013	0·006	0·016	0·004	Trace	Trace	Trace
Manganese	.....	0·44	.....	.....	.....	.....	.....	.....	.....	.....
Titanium	.....	Trace	0·05	0·01	Nil	Nil	.....	.....	.....	Nil

A. d'Invilliers, E. V.: private report, 1900; large general sample along the face of main bluff for 87 feet, as well as from loose ore blown out in blasting.
B. Winchell, H. V.: private report, 1902; said to represent an average sample of the bluff deposit.
C. Ditto, 5-foot sample in tunnel.
D. Ditto, 6-foot sample in winze in tunnel.
E. Ditto, sample from ore pile, mouth of tunnel.
F. Ditto, sample from large open-cut, 300 feet west of tunnel.
G. Lindeman, E.: Bibliography, No. 16, average sample of ore pile.
H. Carmichael, H.: Bibliography, No. 6, sample from ore pile.
J. Brewer, W. M.: Bibliography, No. 21, sample from ore pile.
K. Brewer, W. M.: Ann. Rept., Minister of Mines, 1922, p. 226, average sample from shipment of 10 tons.

These nine samples, taken by five different engineers, from different parts of the deposit, reveal a remarkably uniform grade and a very high desirable tenor of ore. It is safe to say that the Sarita deposit as a whole contains, as far as present exploration goes, the highest grade of magnetite encountered along the west coast of Vancouver island.

Tonnage Estimate

Lack of information concerning the structure of this deposit renders futile any attempt at tonnage estimates. However, one might conservatively say that about 30,000 tons of probable ore occurs in the bluff near the portal of the tunnel, but this quantity would be of much lower grade than the analyses quoted above. Of this amount, about 5,000 tons may be considered as positive or proved ore. Approximately 400 tons of magnetite are in the two ore piles, which would increase the positive ore tonnage to 5,400.

No estimate of possible ore could be made without a knowledge of the structural geology of the deposit.

Value of the Deposit

This deposit has little or no value as an immediate source of iron ore. Considerable underground development as well as diamond drilling would require to be accomplished to determine its extent and value, but such an expenditure would not be warranted until such time as other larger deposits might have furnished the necessary supply of magnetite for the inception of an iron industry.

In spite of its small positive value as an iron ore producer, the Sarita River deposit has one or two interesting points of potential value. (a) It is possible that the ten or twelve small surface exposures are outcrops of bodies of magnetite, which, although they may not extend to any great depth, may spread laterally in nearly flat tabular or lenticular shapes. (b) There are other exposures of magnetite, in places mixed with pyrite and pyrrhotite, several hundred feet to the east, extending to where this east-west ridge meets Sarita river. Brewer (21) reports somewhere to the east, "an occurrence of magnetite on the east bank of a swampy creek that crosscuts the same ridge. . . . An open-cut 10 feet deep by 120 feet long has been made across a part of the ridge, exposing diorite on the south side, next magnetite 62 feet wide, then crystalline limestone 12 feet wide, then magnetite 45 feet wide, to limestone wall. In this deposit the magnetite is good grade." This locality could not be found during the investigation in 1924. (c) The Sarita River, Copper Island, and Sechart Peninsula deposits lie at intervals of 4 and 9 miles along a straight line having the Cordilleran trend. It is interesting to speculate as to whether other deposits might occur along this same line, but it is more than probable that no single zone of mineralization extends for that distance of 13 miles across Barkley sound.

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See page 158 for further details

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6. Carmichael, H., pp. 215-217.
16. Lindeman, E., pp. 12-13.
17. Clapp, C. H., p. 190.
20. Lindeman, E., and Bolton, L. L., pp. 10-11.
21. Brewer, W. M., pp. 16-18.
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29. Ann. Rept., 1900, p. 920.
Ann. Rept., 1901, p. 1096.
Ann. Rept., 1902, pp. 224-225.

(47 b) Copper Island Deposit

(*See* Figures 32, 33, and 34)

LOCATION

Copper island, also called Tzartoos or Tzartus island, is the largest of a chain of islands separating the middle and eastern channels of Barkley sound. It is about 5 miles long in a northeasterly direction, and 2 miles wide, and rises quite steeply along its southeast side to an elevation of nearly 1,000 feet in less than half a mile from the shore. The magnetite deposit is located along this southeastern slope, extending to the top of the ridge, and seems to have its principal exposures on the Mountain claim. The remaining claims of the group, all of which are Crown-granted,

are called Barclay, Clifton, Charmer, Pilot, Rainbow, and Sunbeam. There is no trail to the showings, the old trail having been completely obliterated; but they can be most readily reached from the small bay on the north side of Clifton point from which they are distant 1,800 feet in an horizontal line.

It is interesting to note that a line drawn from the Sarita River deposit to the Crown Prince deposit on Sechart peninsula passes almost directly over the Mountain claim of the Copper Island group, and such a line is parallel to the Cordilleran trend of the rock formations of Vancouver island.

The lower parts of Copper island are thickly timbered with hemlock, spruce, and cedar, but the knoll-shaped top was burnt over several years ago and part of it is now mantled with dense second growth of hemlock and abundant salal brush. The exposures of magnetite occur principally in the burnt-over part, between 650 and 800 feet in elevation; and rock exposures are abundant. The topography of the island is favourable to the exploration of the deposit, since a depth of nearly 800 feet below the highest outcrop could be obtained by means of a tunnel less than 2,000 feet long.

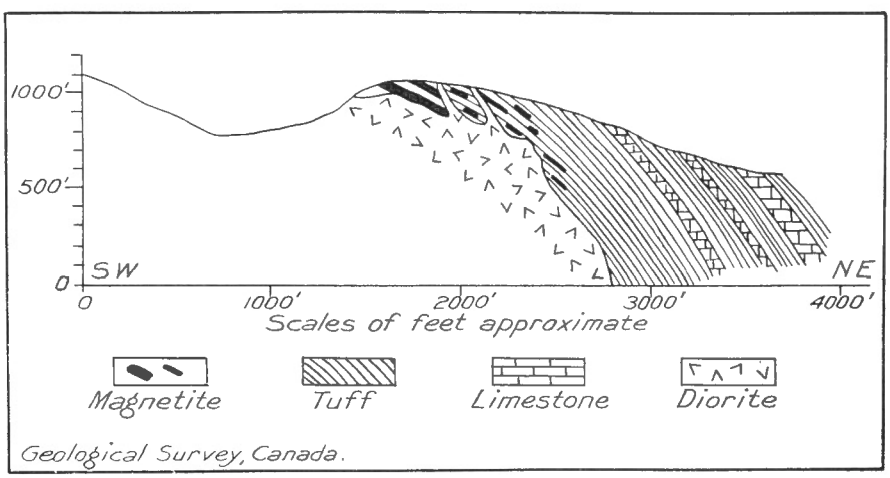

Figure 32. Idealized section through Copper island. The magnetite (solid black) replacing beds of tuff close to underlying intrusive body of diorite.

HISTORY AND OWNERSHIP

The claims were originally staked in 1894 and Crown-granted about 1900. All the exploration and development were accomplished prior to 1902, as described in detail by Carmichael (6, page 218) in his government report, and by H. V. Winchell in a private report in 1902.

The claims are now registered in the name of the Sarita and Copper Island Mining Partnership, 1221 Government street, Victoria, B.C.

GEOLOGY

On Copper island are exposed a series of interbedded limestone, andesite, and andesitic tuff of the Vancouver group, intruded by Beale diorite, which is in turn cut by granodiorite. From Clifton point northward for about one mile the andesite and tuff members, cut by sill-like masses of diorite, occur prominently with general northeasterly dips,

beyond which limestone beds of varying thickness are interlayed with tuffaceous members. The southern and western parts of the island are underlain principally by the two intrusive rocks above mentioned. Striking northwesterly from Clifton point into the heart of the island is a prominent contact between diorite and andesitic tuffs; and it is along this contact that the magnetite deposit is situated. The interpretation of the structure in the vicinity of this contact is given in the idealized section, Figure 31, where it is shown to be of an undulating character plunging to the north with varying dip, lying on top of which are similarly dipping beds of andesitic tuff. This structure is slightly complicated by apophyses of the diorite cutting the sediments, and by dykes of granodiorite intruding all the other rocks. No limestone was observed in the area immediately about the magnetite deposit, and there were no evidences of its metamorphosed equivalents.

The diorite-tuff contact may be observed to dip 25 degrees to 30 degrees northeasterly on the Mountain claim at the summit of the island, and the tuffs in the same locality have about the same dip. This contact steepens to 50 degrees along the water's edge, some little distance to the north, thus giving a clean-cut picture of an intrusion of diorite that has only recently been unroofed.

Replacement of the tuff by garnet, epidote, and cherty quartz with, in large measure, the preservation of the original bedding structure, has taken place close to the diorite contact, and shallow roof-pendants of replaced and unreplaced tuff occur near the top of the island between small cupola-like masses and dykes of diorite and granodiorite.

OCCURRENCE OF THE MAGNETITE

Magnetite occurs, along with garnet and epidote, as a replacement of some of the beds of tuff close to their contact with diorite (*See* Figure 33). In some cases the bedding of the tuff is preserved and is emphasized by the occurrence of thin bands of magnetite ($\frac{1}{4}$ to 4 inches thick) in contact with thin bands of brown garnet or of quartz and epidote. The individual magnetite bands consist of a series of closely spaced, flattened, somewhat irregular lenses up to 2 or 3 feet in length, having the general dip of the tuffaceous rocks. Between the flattened lenses occur various mixtures of the silicates, mostly andradite and grossularite. The structure of the deposit, therefore, is controlled by, and is a function of, the attitude of the dipping sedimentary series.

The tuff and its metamorphosed and mineralized products may be subdivided into separate bodies of relatively pure magnetite, various mixtures of garnet and magnetite, garnetized tuff, and unaltered tuff (*See* Figures 33 and 34). The contacts are gradational. Very little solid magnetite is present, since most of it is not only interbedded, as described above, with silicate layers, but is itself highly impregnated with garnet. The principal bodies of nearly solid magnetite are developed along the sides of three large open-cuts (*See* Figure 33), where a blanket-shaped deposit of magnetite with a maximum thickness of 10 feet occupies a dip slope, and can be seen to be a replacement of a thinly-bedded rock series.

The open-cuts and the tunnels in each case penetrated the foot-wall of the magnetite zone, since they were driven in a direction opposed to the dip. The sheeted dipping structure can be plainly seen on the sides of the southernmost open-cut c.

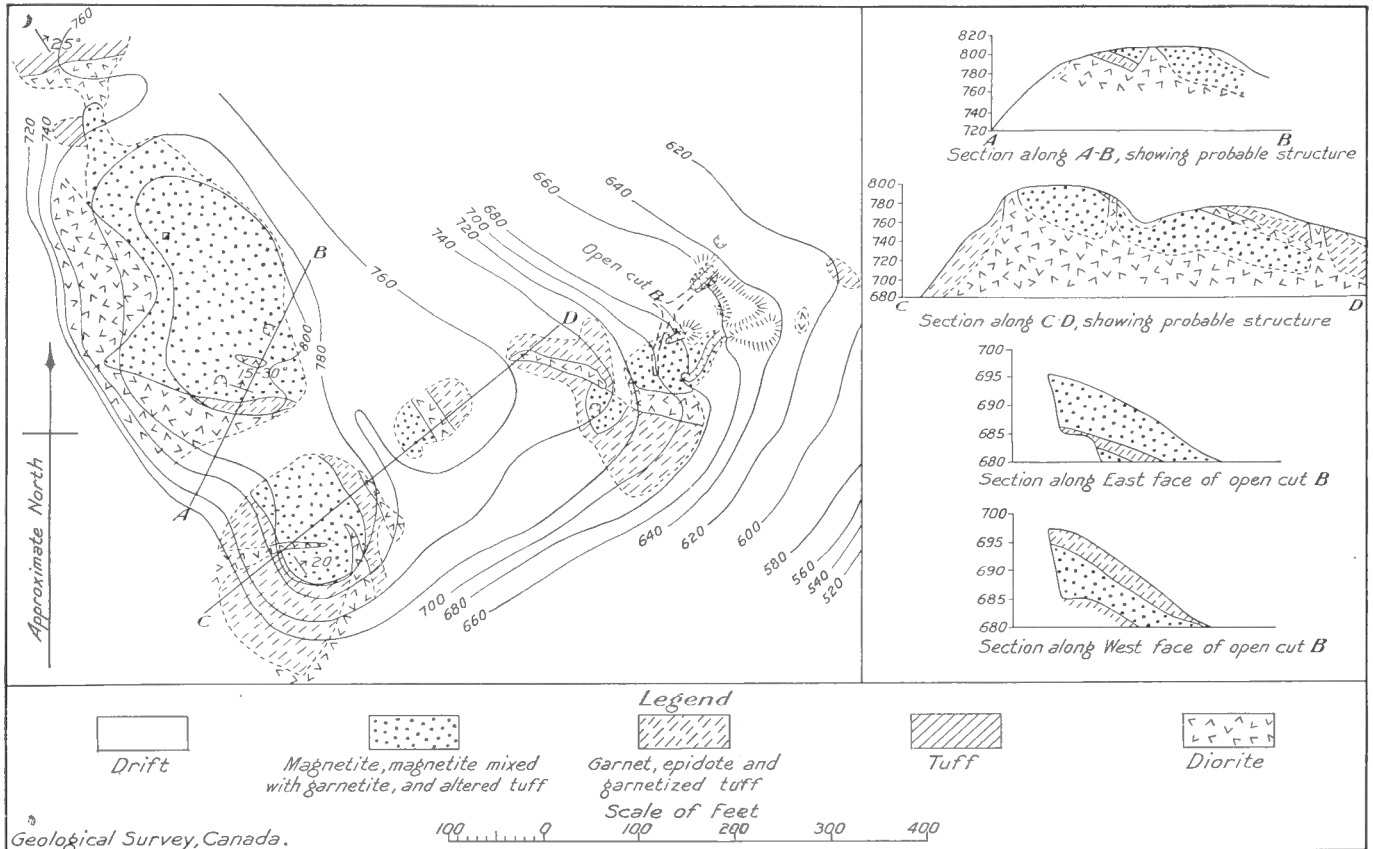

Figure 33. Magnetite deposit, Copper island, Barkley sound, Vancouver island, B.C. Contour interval, 20 feet.

Several small faults were observed within the mineralized tuffaceous rocks, as well as small dykes of granodiorite and fine-grained diorite.

CHARACTER OF THE MAGNETITE

Very little solid magnetite was observed. Within the individual flat lenses, as well as within the 10-foot thick, blanket-shaped mass just mentioned, the magnetite contains considerable fine-grained brown garnet; and this mixture is excellently exhibited by specimens from the two main dumps. The magnetite of this mixture is dense, fine-grained, hard, and lustrous, and is in many places impregnated with some pyrite and chalcopyrite.

ORIGIN OF THE DEPOSIT

This deposit is believed to have been formed as a contact metamorphic development in a series of thinly-bedded tuffs, under the influence of intrusive hornblende diorite; and the structure and details of its occurrence are so conspicuous that it is the type example of this group of deposits of which other representatives are the Crown Prince, Bald Eagle, etc. The origin of the flattened lenticular shapes in which the magnetite is found in the thinly interbanded structures previously described has not been solved, but whatever the solution may be, it will have to take account of the fact that, during their formation, the original stratification of the tuffs was preserved. Replacement and alteration of the material of the tuffs by thermal solutions or gaseous emanations from the cooling diorite seem to afford a plausible explanation, but this was not investigated in further detail.

ECONOMIC CONSIDERATIONS

Extent of Deposit

The iron mineralization extends for about 560 feet along the strike of the tuff beds in a northwesterly-southeasterly direction (Figure 33). Another exposure some distance to the northwest was observed where a small open-cut and tunnel penetrated a zone of mixed magnetite, garnet, and epidote, and taking this into consideration, the total longitudinal extent of mineralization might be in the neighbourhood of 900 feet. Magnetite is also exposed at intervals down the undulating dip slope from the summit of the island at 800 feet to the mouth of the northernmost open-cut (Figure 34), at 655 feet, a vertical distance of 145 feet. Continuations along the strike, down the dip and vertically, beyond the above-mentioned figures, can only be surmised from a realization of the structure as revealed in the idealized cross-section (Figure 32). It is interesting to observe that at Clifton point 1,760 feet horizontally in a southeasterly direction from the large open-cuts, and 650 feet lower in elevation, along the same contact, pyrite and pyrrhotite with very little magnetite occur in the tuffs.

Theoretically, the only limit to the extent of the iron mineralization on Copper island is the extent of the diorite-tuff contact, but, since freakishness is a leading trait of these contact deposits, only that amount of ore can be reckoned on that is actually observed.

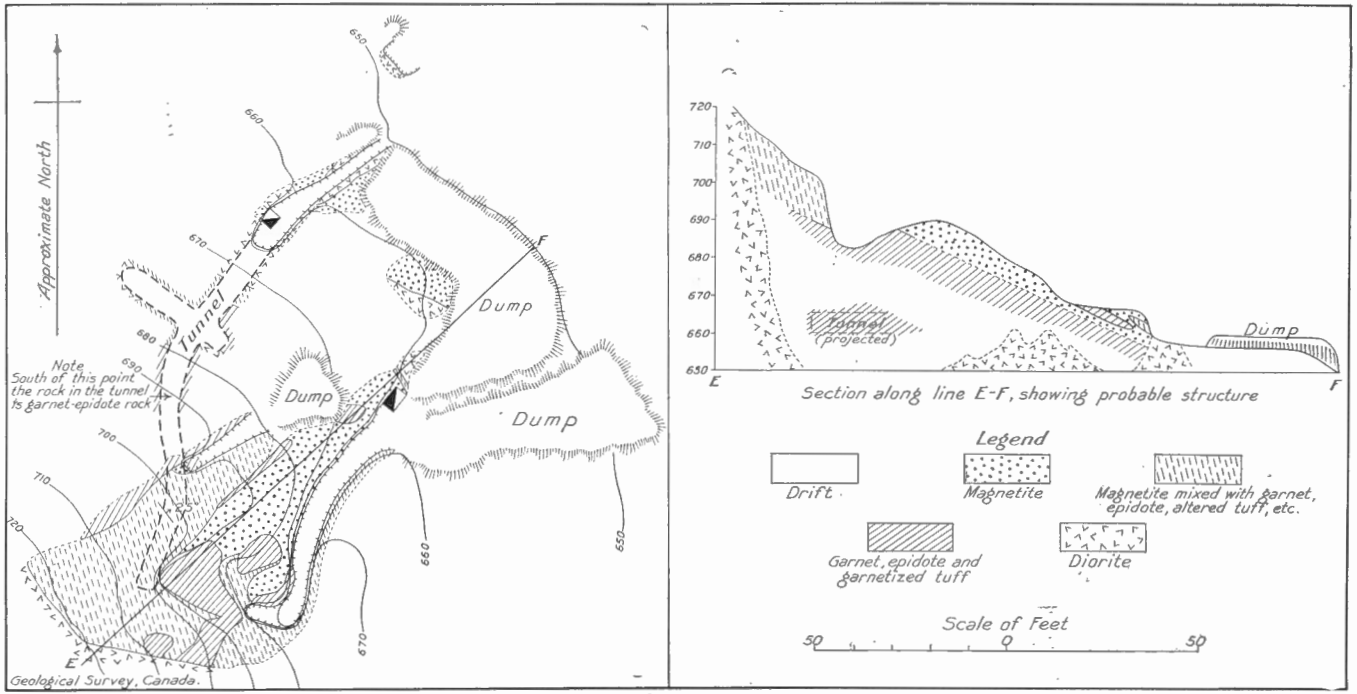

Figure 34. Principal magnetite bodies, Copper island, Barkley sound, Vancouver island, B.C. Contour interval, 10 feet.

Development

The deposit is developed chiefly by two open-cuts and by one tunnel with an open-cut approach. These are respectively 20, 70, and 140 feet in length, but as they all penetrate into the foot-wall and so disregard the structure of the deposit, they have not succeeded in developing any noteworthy body of ore. Two shallow shafts, now full of water, were found near the entrances of two of the open-cuts, but previous reports indicate that these encountered country rock at their bottom. Several small open-cuts, pits, and shafts were observed on the summit of the hill above the 780-foot contour, but these added nothing to the development of the deposit.

Analyses

A few analyses are available, and are here recorded for what they may be worth. They represent samples that have been taken, without doubt, from the higher grade part of the deposit.

——	A	B	C	D	E	F	G	H	J
Iron	62·65	58·8	48·51	54·33	50·97	40·24	52·09	56·2	50·4
Phosphorus	0·035	0·049	0·058	0·049	0·098	0·028	0·025	nil	0·053
Silica	6·24	9·13	14·78	9·44	13·0	21·90	.....	17·0	18·6
Sulphur	.....	.....	1·41	1·51	2·22	0·51	0·230	1·3	0·3
Manganese	.....	.....	0·24	.....	.....	.....	.....	.....	.....
Titanium	.....	.....	nil	nil	nil	nil	.....	.....	trace
Insoluble	.....	.....	.....	.....	.....	.....	16·52	.....	.....

A. d'Invilliers, E. D.: private report, 1900, general sample from "float, boulders, and seams in the rock mass."
B. Ditto, from small tunnel and open-cut northwest of map-area. "General sample of this ore pile and from both sides of tunnel, cut, and outcrop above tunnel."
C. Winchell, H. V.: private report, 1902, "Analysis of average sample of ore."
D. Ditto, "south cut east end of workings."
E. Ditto, "ore pipe, mouth of tunnel."
F. Ditto, "outcrop, pinnacle of island."
G. Lindeman, E.: Bibliography, No. 16, "average sample of ore pile."
H. Brewer, W. M.: Bibliography, No. 21, "sample of solid magnetite."
J. Carmichael, H.: Bibliography, No. 6, "average sample of the ore on the dump."

All of these analyses confirm the statements contained in this report regarding the comparatively low grade of the Copper Island magnetite.

Tonnage Estimate

Since no body of ore of commercial grade is known to occur on this property, a tonnage estimate of the mixed magnetite and garnet is not considered worth while. The material of this deposit would have to be beneficiated before any of it could be shipped.

There are about 100 tons of the best grade of magnetite piled on the dumps at the mouths of the three larger open-cuts.

Value of the Deposit

The deposit is of no value as an immediate source of iron ore, and offers very few indications of potential value. It is placed, therefore, in the group of deposits of no value.

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See page 158 for further details

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(48) Sechart Peninsula Deposits

LOCATION

Sechart peninsula is the most prominent projection into Barkley sound, and, together with the group of islands to the south of it, it separated the western and middle channels. It is almost entirely enclosed by Pipestem inlet on the north, the western channel on the south, and Effingham inlet on the east. In the heart of the peninsula rise the peaks of Broughton range to an altitude of 3,000 feet, and on the southern slopes of this range at elevations varying between 700 and 1,000 feet and distances of 1 to 3 miles from the shore are the group of deposits now to be described.

HISTORY AND OWNERSHIP

"During the early nineties Captain Anderson located several mineral claims because of the occurrences of magnetite, some of which he sold during 1901 to the Pacific Steel Company, Washington state, and others to the Tacoma Steel Company, of the same state. The claims were later Crown-granted as lots numbered 456, 457, 458, 459, 374, 392, 695, and 696, and at present are assessed to the following owners:

"Lot No. 456, Crown Prince claim, to the estate of the late Homer Swaney.
"Lot No. 457, Victoria claim, to the estate of the late W. H. Flett.
"Lot No. 458, Old Ireland claim, to the estate of the late W. H. Flett.
"Lot No. 459, Bald Eagle claim, to the Tacoma Steel Company.
"Lot No. 374, Iron Chief claim, to the Tacoma Steel Company.
"Lot No. 392, Standard No. 6 claim, to the Tacoma Steel Company.
"Lot No. 695, Lord of the Isles No. 4 claim, to the Tacoma Steel Company.
"Lot No. 696, Emily R. claim, to the Tacoma Steel Company." (21, pages 24-25).

The Western Steel claim of the original series was relocated in 1902 as the Iron Chief of the above list. It has now reverted to the Crown.

The principal showings are on the Crown Prince, Lord of the Isles No. 4, Bald Eagle, and Western Steel (Iron Chief) claims, and most of the development on these showings was done prior to 1903, as it is described with a geological sketch of the Crown Prince tunnel by Carmichael in 1902 (6, pages 211-212).

(48 a) Crown Prince Deposit

(*See* Figure 35)

LOCATION

The Crown Prince mineral claim is near the eastern extremity of the group, and lies on the eastern slope of Broughton range, overlooking the mouth of Effingham inlet, from which it is distant one mile as the crow flies. The deposit may be reached by a fair trail leading from Sechart whaling station, on the southwest side of the peninsula, in a northeasterly direction for 2 miles to a cabin on Lord of the Isles claim. After this point the trail is obliterated, but may be located again after travelling about 2,000 feet in a northeasterly direction through thick underbrush. The old trail connecting this deposit with the others to the west has been obliterated by forest fires and underbrush, which have made the intervening country impossible of investigation.

The country covered by the Crown Prince claim slopes rather steeply to the east and southeast down to a timber-covered bench below the workings, from which a gradual slope leads down to tidewater in the protected channel between Narrow island and the shore. In the vicinity of the showings, the altitude varies from 750 to 900 feet. Much of the timber has been felled, and in consequence a very dense growth of underbrush and small evergreens has sprung up rendering travelling most difficult. Below the claim, the country is well timbered with hemlock, cedar, balsam, and some spruce; while above the principal showing a hummock reaching 1,130 feet in elevation, and well timbered, stands out in relief against the burnt-over higher slopes of Broughton range.

GEOLOGY

The shorelines of Sechart peninsula and adjacent islands show almost continuous exposures of Beale hornblende diorite, with a few roof pendants of crystalline limestone, and andesitic volcanics of the Vancouver group. On Narrows island, 1½ miles due east of the Crown Prince deposit, the diorite is traversed by an intrusive mass of granodiorite, similar to that occurring in other parts of Barkley sound.[1]

Around the deposit, however, only two exposures of intrusive rocks occur, both of granite and both of very small size. Most of the country rock exposed is a fine to medium-grained, banded, silicified andesitic tuff (of the Vancouver series), whose limited exposures point to an east-west strike and a varying northerly dip. This tuff is traversed in places by narrow dykes of fine-grained granite or quartz monzonite, and under the microscope thin sections of this tuff show an abundance of tiny vein-like stringers and bunches of quartz monzonite, giving the general effect of feldspathization of the rock. The most northwesterly exposure of tuff in the area of Figure 35 occurs along a southerly facing cliff and shows a marked banding and crystallinity, causing the rock to resemble a biotite gneiss. It is probable that this structure and texture is given to the tuff by the lit-par-lit injection of thin intrusive sills of the same origin as the feldspathization just mentioned.

No hornblende diorite, elsewhere so widespread, was observed on the claim, and no intrusive contact of any importance was encountered. Limestone does not occur, or at least is not exposed.

[1] Observations made from yet unpublished geological maps of west coast of Vancouver island, by V. Dolmage.

OCCURRENCE OF MAGNETITE

The magnetite occurs as an irregular and spotty replacement of the tuff beds, associated with considerable garnet and metamorphosed tuff. No evidence was obtained that would indicate that limestone was the host rock, although minor amounts of calcite occur in places with the magnetite and the garnet.

The belt of mineralization cuts obliquely in a northwest direction across the steep slope of the ridge, and the exposures are too few and generally too isolated to afford sufficient data for a detailed description or

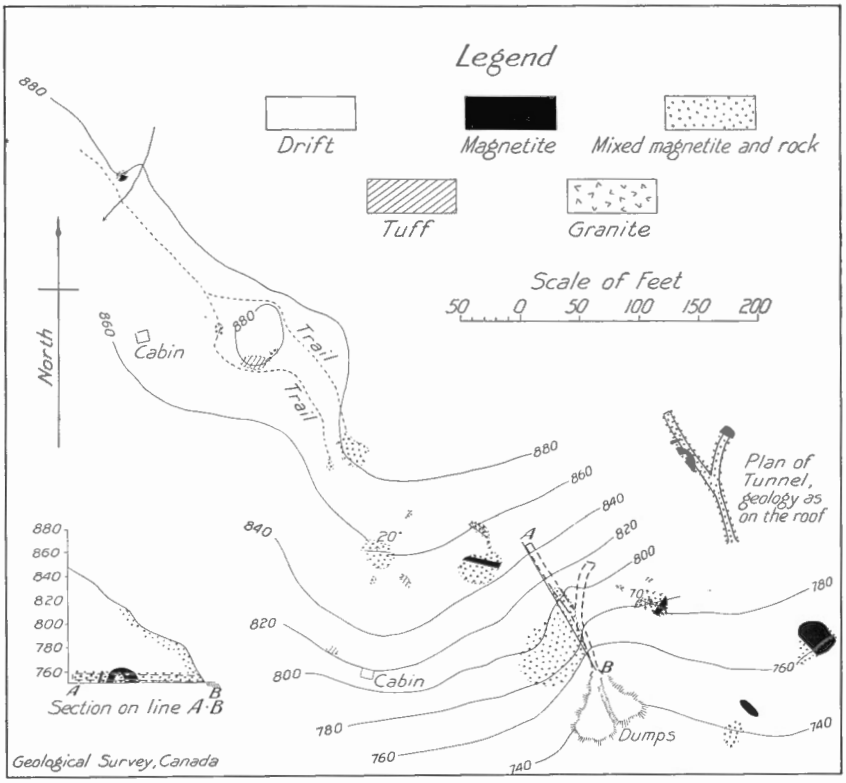

Figure 35. Magnetite deposits, Crown Prince claim, Sechart peninsula, Barkley sound, Vancouver island, B.C. Contour interval, 20 feet.

interpretation of the occurrence. As mentioned above the bedded tuffs appear to strike nearly east and west, and dip into the hill; in two places the same bedding structure is preserved in the magnetite-garnet complex, with, in one case, a dip of 20 degrees, and in the other 70 degrees, to the north. On the top of the bluff of mixed magnetite and rock, just above the portal of the tunnel, this bedded or banded structure is again prominent with individual layers up to one foot thick dipping to the north. Within the tunnel, no data were obtained that would tend to elucidate the structure of the deposit.

Both tabular and irregular-shaped masses of relatively solid magnetite are exposed, one in an isolated exposure, three others as tabular bodies associated with garnetized, metamorphosed tuff, and irregularly mixed garnet and tuff, and one other, at the northwest extremity of the area, in contact with a small, isolated exposure of granite. The largest of these masses is east of the tunnel and it is 20 feet in width and 30 feet long in an uphill direction. The tunnel also shows three small masses of nearly solid magnetite, but these, also, are too small to be of any importance.

Most of the magnetite on the Crown Prince claim occurs interbedded or irregularly mixed with garnet or metamorphosed tuff in a ratio by volume roughly estimated as 50 to 50.

CHARACTER OF THE MAGNETITE

Outside of the five small areas mapped as solid magnetite, where the magnetite is fine-grained, hard, blocky, and quite pure, most of the showings on this property consist of intimately mixed magnetite and gangue. Most of this gangue consists of silicates, such as garnet, epidote, and the altered silicates of the tuff, with very little free quartz. The bedded structure of much of the magnetite would seriously interfere with its commercial extraction, as the individual layers are usually not over one foot thick, and in most cases less than that.

Three grades are present: (a) magnetite, including those bodies containing about 70 per cent by volume of magnetite; (b) magnetite mixed with rock in an approximate 50 : 50 ratio; and (c) contact metamorphosed rock, including contact silicates with impregnations, lenses, and small bunches of magnetite, not over 20 per cent by volume. The contacts between these different grades are, of course, gradational.

ORIGIN OF THE DEPOSIT

The deposit is believed to have originated by replacement of the series of bedded tuffs under the influence of an intrusive magma, whose outcrops as observed on the Crown Prince claim are extremely limited. The deposit is very similar in structure and mineralogy to the one on Copper island, where the intrusive and the contact metamorphic nature of the deposit are plainly evident.

Granite or monzonite underlies quite a large area extending from the exposures on the Bald Eagle claim in a northeasterly direction at least as far as a point 600 feet southwest of the southwest corner of the Lord of the Isles No. 4 claim. Whether this intrusive is the same as that found in the two small exposures and in the small dykes and veinlets on the Crown Prince claim has not been determined; but judging from a comparative study of the various deposits of magnetite along the coast, the writer feels inclined to suggest that here again the iron mineralization is due to the intrusion of diorite, so extensively exposed along the shores of Sechart peninsula, and that the more acidic monzonitic or granitic intrusives exposed on the claims are subsequent invasions, dykes from which in some cases cut the magnetite.

ECONOMIC CONSIDERATIONS

Extent of Deposit

The outcrops of magnetite, and magnetite mixed with rock, occur at intervals through a northwest-southeast distance of 700 feet, and are separated from each other by areas of drift from 20 to 280 feet in width. The outcrops occur throughout a vertical range of 150 feet. Little may be said of the extent of the mineralization beyond these limits, since the country is covered by glacial drift and timber; but in estimating the possible extent of the various bodies of magnetite examined, the following topographic fact was made use of, namely, that where solid bodies of magnetite were cut by the present topography, they were found to stand somewhat in relief above the general slope, as a hummock or a bump. Such relief features were not observed along the continuation of the line of magnetite exposures in this claim. However, it is not fair to assume that all the individual or separated bodies of magnetite on the claim should extend upwards to the surface.

Development

One tunnel, 125 feet long, with a side drift 50 feet long from it, three open-cuts, and several strippings are all the development seen on the claim at the present time.

Analyses

The following analyses seem to give a fair idea of the grade of the deposit:

—	A	B	C	D	E	F	G	H	J
Iron	35·33	53·49	24·77	37·64	26·97	48·4	48·06	56·6	55·6
Phosphorus	0·020	0·006	0·031	0·020	0·020	trace	0·006	nil	trace
Manganese	0·20	.....	.....	.....	.....	.....	.....	.....	.....
Silica	19·86	10·12	25·48	19·54	24·48	.....	.....	19·0	17·6
Insoluble	8·98	.....	.....	.....	.....	.....	23·22	.....	.....
Sulphur	0·84	1·05	0·46	0·55	1·34	0·7	0·623	0·72	0·4
Titanium	trace	nil	trace	0·02	0·04	trace	.....	.....	.....

A. Winchell, H. V.: private report, 1902, analysis of average sample from the deposit.
B. Ditto, face of tunnel, 100 feet from mouth, all in one.
C. Ditto, sides of tunnel, 70 feet from mouth.
D. Ditto, sides of tunnel, 30 feet into drift.
E. Ditto, sides of tunnel 70 feet into drift.
F. Carmichael, H.: Bibliography, No. 6, sample not described.
G. Lindeman, E.: Bibliography, No. 16, average sample of ore on dump.
H. Brewer, W. M.: Bibliography, No. 21, average sample across the face.
J. Ditto, average sample taken along 28 feet on the left side of the branch adit.

These samples, taken by both government and private mining engineers, reveal a wide variation in the grade of the ore from a very rocky, impure grade to fairly solid magnetite. Very little of the material represented by the above analyses could be shipped without beneficiation.

Tonnage Estimate

It is impossible with the available data to make any estimate of reserves, proved, probable, or possible.

Value of the Deposit

This deposit is one of the largest seen, in respect of the longitudinal extent of exposures, but in view of the isolation of the various outcrops, and the general low grade of the ore, the deposit is of no value as an immediate source of iron ore.

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See page 158 for further details

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18. Thompson, N., pp. 198-201.
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Carlyle, W. A.: "Report on the Alberni Mining District"; Bur. of Mines, Victoria, B.C., Bull. No. 1, 1896-97, pp. 4-5.

(48 b) Bald Eagle Deposit

(*See* Figure 36)

LOCATION

The Bald Eagle Crown-granted mineral claim is located on the southern slope of Broughton range of mountains, overlooking Sechart channel, and is almost due north of the old whaling station (present Imperial Oil Company's station) at Sechart. The deposit may be reached by a fair trail leading from the whaling station along the shore in an easterly direction for half a mile, then for about 2 miles northerly to an old cabin, close to the workings on the claim.

The deposit occurs as a bold bluff on a timbered and otherwise drift-covered hill-side at elevations from 825 to 865 feet (barometric) above sea-level. From the base of the bluff to the top of the ridge to the north is a large stretch of burnt over country, with some tall, pole-like timbers still standing, but with most of the trees slashed down, forming an almost impossible "jackpot". A dense growth of underbrush greatly accentuates the difficulty of travelling over the claim. Below the showing, the country is clothed with cedar, hemlock, balsam, etc., some of the timber being of considerable size.

GEOLOGY

In the vicinity of the deposit are exposures of crystalline limestone, hornblende diorite, granite, and altered volcanic rocks (probably tuffs), but the relationships between these, due to lack of connected esposures, are not clear. No limestone was found in contact with the body of magnetite; both diorite and granite occur along its boundaries. Diorite is found in contact with limestone at the western edge of the area mapped, but there is no magnetite developed there. Small areas of fibrous, contact silicates (tremolite, actinolite, etc.) occur in places, but these appear to be associated both with the diorite and the granite, not, however, in any location where their relationships may be readily interpreted. No geological structure was observed in the area mapped.

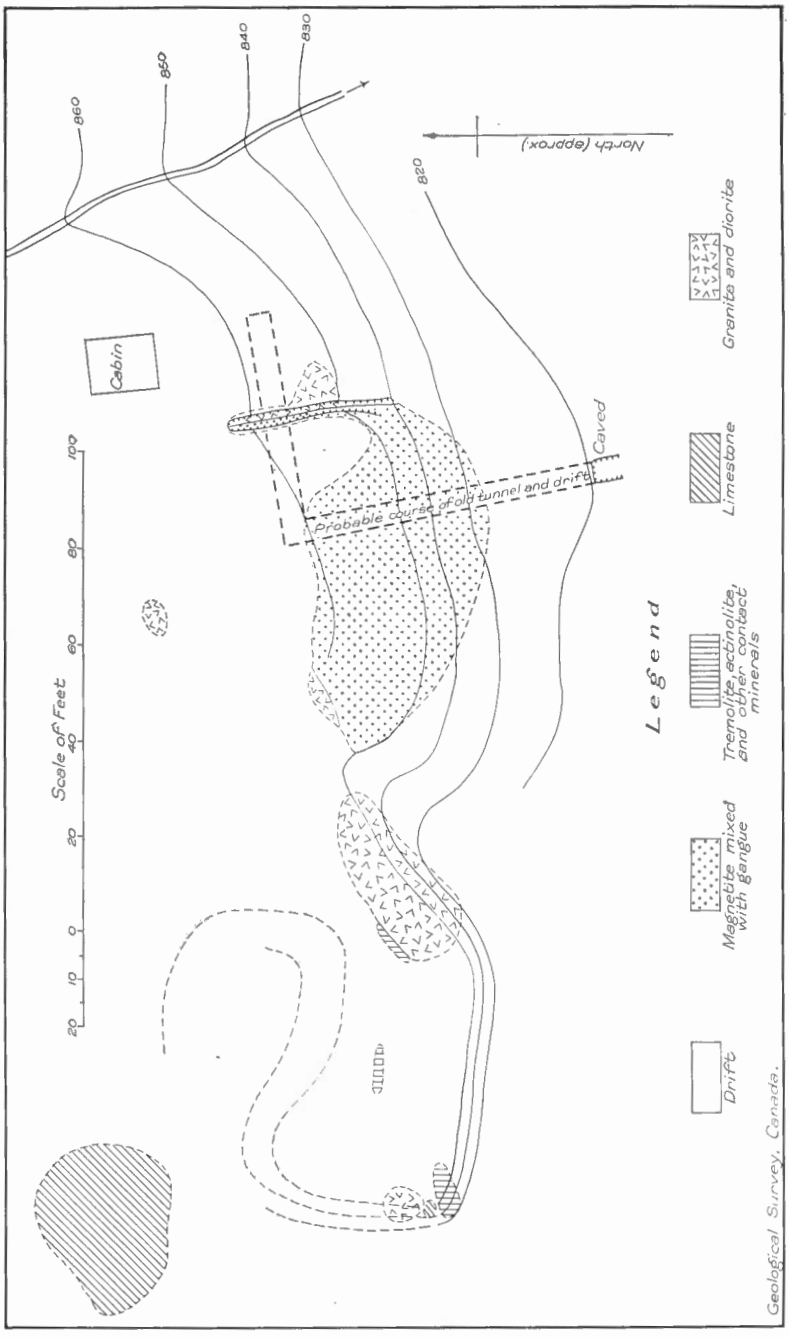

Figure 36. Magnetite deposit, Bald Eagle claim, Sechart peninsula, Barkley sound, Vancouver island, B.C. Contour interval, 10 feet.

Although not proved, it is believed from other studies in Barkley sound that the granitic intrusive is of later date than the diorite, and may even be found to cut the magnetite. As shown by the geological map of the west coast of Vancouver island, mentioned above (page 206), diorite is the principal country rock, including limestone as roof pendants, and traversed by dyke-like bodies of the more acidic granodiorite and allied types.

OCCURRENCE OF THE MAGNETITE

Magnetite occurs, mixed with highly metamorphosed, fine-grained rock, in a prominent bluff facing south. There is no body of magnetite in the entire outcrop pure enough to map as such, so that the deposit is outlined as "magnetite mixed with gangue". Fine-grained dyke-like stringers and irregular masses of aplite occur in places within the magnetite. The lode is confined by bedrock walls along its easterly margin where it is in contact with a garnetized phase of granite, and along a small part of its northwest edge where it lies against a small exposure of hornblende diorite.

The attitude or structure of this deposit is not clear. In the face of the bluff there is a rude interbanding of magnetite and rock, that appears to give the lode a dip to the south parallel to the slope of the hill. If this dip were less than 24 degrees the lowest exposure of magnetite at the bottom of the bluff would in its southerly extension pass over the portal of the tunnel. This would appear to be the probable solution of the structure, since, as stated by Brewer (21, pages 26-27), "an adit is driven 72 feet into the bluff under the outcropping, about 40 feet vertical measurement below the top, and at the face a drift is driven 45 feet to the right. No magnetite is exposed by this work, which confirms the blanket-structure theory". The portal of the tunnel was in a caved condition in 1924, making access impossible. The dump was observed to contain fragments of the rocks exposed around the lode, but no magnetite.

CHARACTER OF THE MAGNETITE

The outcrop of the deposit is very rusty, due to oxidation of sulphides which are quite abundant; the mixture with rock is on such a scale as to reduce the content of magnetite to about 50 per cent of the whole. The magnetite itself is very much fractured, and crumbles into small pieces readily.

ORIGIN OF THE DEPOSIT

The deposit is believed to be of contact metamorphic origin and to have been developed in a flatly dipping series of tuffs under the influence of intrusive hornblende diorite. The evidence for this hypothesis of origin is partly taken from the deposit and is partly based on a comparative study of similar occurrences. The low dip, the bedded structure, and the general impurity and mixture with rock, suggest a similarity of this type with the replacement of bedded tuffs at the Crown Prince and on Copper island, although unaltered or at least recognizable tuff was not found to occur in the proximity of the outcropping. Limestone is exposed in two places, but in neither place does it contain any magnetite nor is any limestone found, even in fragments, associated with the magnetite.

The intrusive from which the iron solutions emanated is believed to be the diorite rather than the granite, since in places the granite may be observed to intrude the diorite and to be present in dyke-like stringers in the magnetite. In addition, comparative regional evidence points to the diorite rather than the granite as the source of the iron.

ECONOMIC CONSIDERATIONS

Extent of Deposit

The deposit extends for 75 feet along the hill-side and has a maximum width of exposure (measured on the horizontal) of 40 feet. If the blanket or nearly flat-lying structure suggested above is correct, and there is no ore in the tunnel, the depth would not be greater than 15 or 20 feet. There is very little opportunity for any noteworthy longitudinal extension of the deposit, on account of the granite exposures close to both ends.

Development

A tunnel reported by Brewer to be 72 feet long, with a 45-foot drift at its face, and some old stripping, now obliterated by subsequent growth, constitute the development.

Analyses

No representative analyses from this deposit are available. The two analyses quoted below are manifestly taken from selected samples of the best grade of magnetite.

—	A	B
Iron	59·37	60·7
Sulphur	0·716	Trace
Phosphorus	0·006	Trace
Silica	.....	13·6
Insoluble	13·36	.....

A. Lindeman, E.: Bibliography, No. 16, "Average sample of the exposure above the drift."
B. Brewer, W. M.: Bibliography, No. 21, "A sample from the bluff."

Tonnage Estimate

Since no magnetite of commercial grade was found in the deposit, no estimate of tonnage is offered.

Value of the Deposit

The deposit is of no value as a source of iron ore.

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See page 158 for further details

6. Carmichael, H., p. 212.
16. Lindeman, E., p. 15.
18. Thompson, N., pp. 198-201.
20. Lindeman, E., and Bolton, L. L., pp. 11-12.
21. Brewer, W. M., pp. 26-27.
22. Whittier, W. H., pp. 52-55.
29. Ann. Rept., 1901, p. 1095.

(48 c) Iron Chief or Western Steel Deposit

(*See* Figure 37)

LOCATION

The old Western Steel Crown-granted mineral claim, relocated and Crown-granted as the Iron Chief claim, is the most westerly of the Sechart group and lies very close to the Bald Eagle on the northwest. It is on the southern slope of Broughton range, and is reached by a trail leading westerly from the outcrop on the Bald Eagle.

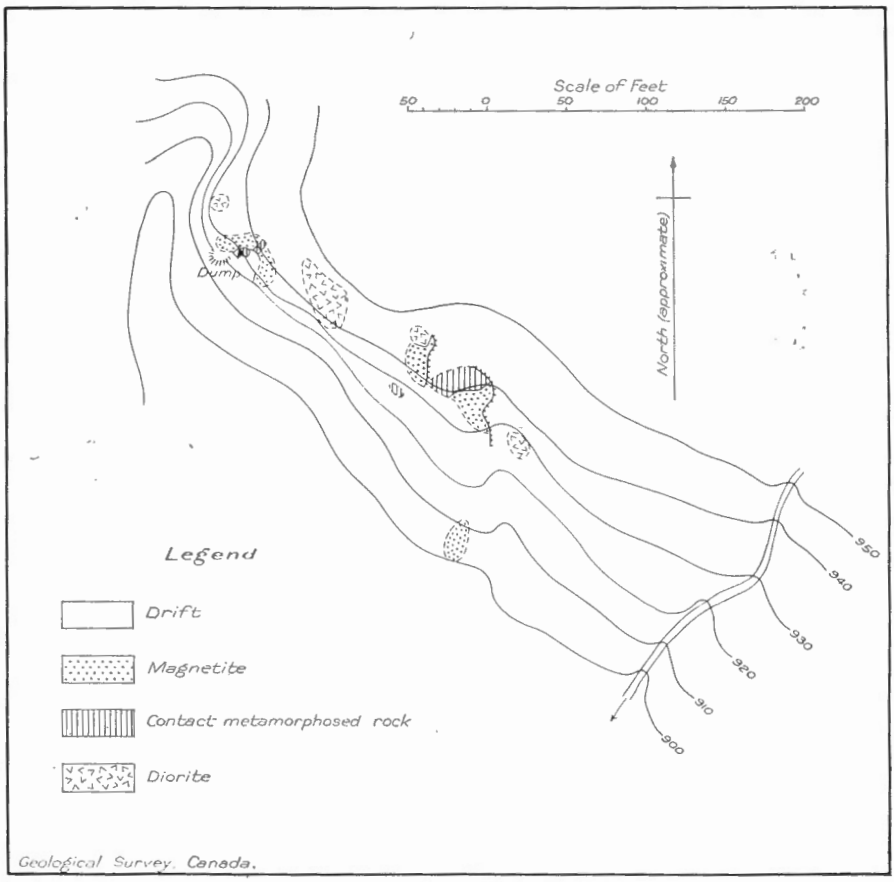

Figure 37. Magnetite deposit, Iron Chief claim, Sechart peninsula, Barkley sound, Vancouver island, B.C. Contour interval, 10 feet.

The deposit occurs on a bench on the mountain side, at an average elevation of 920 feet (barometric) above sea-level. On parts of the claim there is a good stand of timber consisting of hemlock, spruce, and balsam. In the area embracing the outcrops, all the large timber has been cut and the ground was subsequently burnt over. A very dense, almost impassable second growth of hemlock and cedar, 3 to 4 inches in diameter, now obscures most of the area, including many of the outcrops, and made the investigation

very difficult. Glacial drift appears to be thick, except over some of the exposures, and a small creek flowing through the property has cut a channel 10 feet deep in the drift.

GEOLOGY

The only rocks exposed are hornblende diorite, contact metamorphic rock (principally garnet), and small apophyses of granite cutting the diorite. Neither limestone nor volcanic rocks occur, as far as could be observed. Most of the exposures are isolated, and magnetite is in contact with diorite at only one place. The relationship of the granite apophyses to the diorite is the same as that observed in the Bald Eagle, and as that suggested for the Crown Prince.

OCCURRENCE OF THE MAGNETITE

The magnetite occurs in four isolated exposures, strung out for 250 feet in a northwesterly-southeasterly direction, principally in contact with contact metamorphosed rock (largely garnet). The host rock of the magnetite is not known, and no structure that has so far led to its recognition is preserved in the magnetite. All that can be said of the occurrence is that the magnetite is found exposed in four bodies showing no connexion with one another, and indicating nothing with respect to the attitude or structure of the deposit as a whole.

CHARACTER OF THE MAGNETITE

The magnetite is much purer than on the Bald Eagle or Crown Prince claims. It is much more solid, is generally free from sulphides, but is mixed with various amounts of garnet. What is mapped as magnetite contains less than 25 per cent by volume of admixed garnet.

ORIGIN OF THE DEPOSIT

No assured mode of origin can be assigned to this deposit as a result of the data obtained from the investigation. The characteristic association of magnetite, garnet, and hornblende diorite, however, suggests a contact metamorphic origin similar to the Crown Prince and Bald Eagle, but the absence of unaltered limestone or volcanics prevents a statement of the nature of the replacement.

ECONOMIC CONSIDERATIONS

Extent of Deposit

The four outcrops of magnetite have the following approximate surface dimensions:

Feet	Square feet
45 × 10	= 450
30 × 10	= 300
30 × 13	= 390
25 × 10	= 250
Total area	1,390

At the edge of the most northwesterly exposure there is a shaft, believed to be from 15 to 20 feet deep, full of caved rock at the bottom. Since there is magnetite exposed for its full depth, there is reason to believe that that body of magnetite has a surface area of 450 square feet and a

depth of at least 15 feet. The other exposures show no indications of their depth.

In 1907 a magnetometric survey was made of this claim by E. Lindeman (16, pages 14-15) "to obtain some information regarding the extent of the ore. The accompanying map (No. 49) of the vertical magnetic intensity, indicates that the occurrence is very irregular." This map by Lindeman shows no indications of magnetite bodies beyond present exposures for distances of at least 100 feet.

Development

No development, except the shallow shaft above mentioned, can be seen at the present time.

Analyses

The following analyses are taken from private and published reports on the deposit.

—	A	B
Iron	65·1	59·69
Phosphorus	0·054	0·016
Manganese	nil	
Silica	4·720	
Sulphur	.....	0·040
Insoluble	.....	12·76

A. d'Invilliers, 1900, private report, "selected ore."
B. Lindeman, E.: Bibliography, No. 16, "average sample of the ore."

Tonnage

There is no proved ore on the property. The only statement that can be made regarding probable or possible ore is that for every 10 feet of depth below present exposures there would be 1,700 tons of magnetite, but no guarantee can be given that any of the separate bodies of magnetite descend that far except the one whose depth is proved by the shaft.

Value of Deposit

The deposit is of no value as a source of iron ore.

Bibliography

See page 158 for further details

6. Carmichael, H., p. 212.
16. Lindeman, E., pp. 14-15.
18. Thompson, N., pp. 198-201.
20. Lindeman, E., and Bolton, L. L., p. 12.
22. Whittier, W. H., pp. 52-55.

(48 d) Lord of the Isles No. 4 Deposit

LOCATION

This magnetite deposit is on a precipitous, southerly facing bluff, about 500 to 600 feet north of the trail leading to the old whaling station at Sechart. The location of the magnetite is about midway between the showings on the Bald Eagle and Crown Prince claims.

Magnetite occurs at an elevation of 800 or 900 feet on the face of the above-mentioned bluff. The bluff is too steep to support any timber and only light shrubbery can cling to the rocks, which are mostly bare of glacial drift. Hemlock, balsam, and cedar are, however, abundant along the trail, 200 to 300 feet below the showing.

GEOLOGY AND OCCURRENCE OF MAGNETITE

This deposit is of no importance, so that only a brief examination of it was made. The bluff is composed of limestone, and near the top a few irregular masses of magnetite are exposed. In a small crevice, a tunnel of unknown length (now inaccessible) has been driven, from which a stream of water issues.

The following description of the occurrence is taken from Brewer (21, page 26) who made an examination in 1916:

"The face of the bluff is heavily stained with iron from the decomposition of iron pyrites, and the magnetite is mixed with pyrites, garnetite, and limestone. An adit is driven towards the north in magnetite, along a wall of green hornblendic igneous rock, for about 20 feet, then a belt of crystalline limestone is exposed and the course of the adit changed eastward. This course is continued for about 37 feet, driven in magnetite along a limestone wall on the north. At the face there is a winze, apparently sunk in magnetite; this winze is of unknown depth and being full of water could not be examined.

"The dimensions are 13 × 10 feet across the top, with the east wall in igneous country rock that appears to cut off the ore. The adit is continued 40 feet northward in limestone beyond the turn to the east. It is impossible to estimate quantity of magnetite from the work done, which shows that the occurrence is very irregular in outline, lenticular in structure, and apparently not very extensive, unless drilling should prove that it maintains continuity with depth. The dip of the limestone wall in the east drift is nearly vertical, and it is possible that the magnetite may continue down along this wall.

"A grab sample from the dump assayed:

	Per cent
Iron	50·4
Sulphur	2·4
Phosphorus	Trace
Insoluble matter	10·6"

ORIGIN OF THE DEPOSIT

The magnetite is evidently a contact metamorphic deposit in limestone, although the character of the intrusive rock is not carefully described.

VALUE OF THE DEPOSIT

The deposit is of no value as a source of iron ore.

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See page 158 for further details

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18. Thompson, N., pp. 198-201.
21. Brewer, W. M., p. 26.
20. Lindeman, E., and Bolton, L. L., pp. 11-12.
22. Whittier, W. H., pp. 52-55.
29. Ann. Rept., 1899, pp. 783-784.
Carlyle, W. A.: "Report on the Alberni Mining District"; Dept. of Mines, B.C., 1896-97, p. 4.

(48 e) Old Ireland and Standard No. 6 Mineral Claims

Other minor magnetite showings are said to occur on these claims, but they could not be located on account of dense second growth, underbrush, and fallen timber. They are mentioned in a private report made over twenty years ago, but the geological descriptions contained therein are so inaccurate and unreliable that no purpose would be served by reproducing them here.

Bibliography

See page 158 for further details

6. Carmichael, H., p. 212.

(49 a) Darby and Joan Deposit, Alberni Canal

(*See* Figure 38)

LOCATION

This magnetite deposit is located about 600 yards east of Smiths landing, which is on the eastern side of Alberni canal, 12 miles from Port Alberni, and just below the newly constructed Canadian National railway grade.

The showings are along a low, steep, westerly slope, facing the canal. The country has been burnt over, and a great deal of fallen timber, second growth, and underbrush have obscured the workings and have made travelling and examination arduous. The elevations of the deposit are from 85 to 150 feet above sea-level.

HISTORY AND OWNERSHIP

The Darby and Joan mineral claims were claims of record in the name of George and A. Smith, Alberni, but they have now lapsed. All of the development was accomplished prior to 1903, as it is described with geological sketches by Carmichael in his 1902 annual report (6, pages 213-214).

GEOLOGY

There is at Smiths landing an easterly dipping group of porphyrites, andesitic tuffs and breccias, and limestone, belonging to the Vancouver series and the Sutton limestone formation. The dips, as far as they were determined, were found to vary from 40 degrees to 55 degrees. A belt of brownish-red and greenish tuff occurs along the shore of the canal, and is overlain to the east by a belt of fine-grained, grey limestone. This is

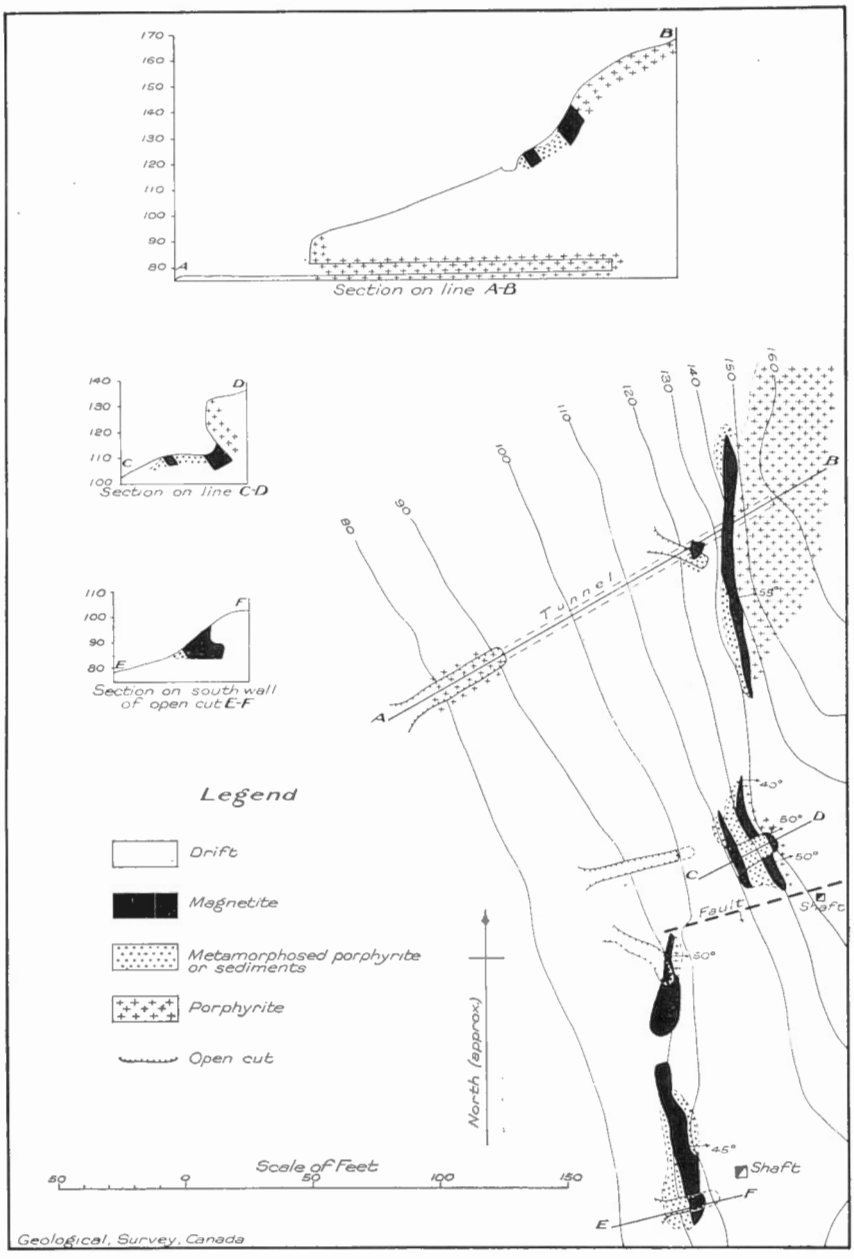

Figure 38. Magnetite deposit, Darby and Joan claim, Alberni canal, Vancouver island, B.C. Contour interval, 10 feet.

17135—15

succeeded by a series of altered volcanic rocks (interstratified tuffs, breccias, flows, or sills). East of these is a marked longitudinal depression with no rock exposures, beyond which is the steep side hill on which the magnetite occurs, underlain by an easterly dipping series of highly altered rocks, partly rosette porphyrite and partly tuff and breccia. Continuous exposures of massive rosette porphyrite extend easterly from the hanging-wall of the magnetite zone at least to the cliffs east of the railway grade. It is also found beneath the foot-wall of the magnetite and is believed to be in the form of sills. It is intensely altered to garnet and epidote on both sides of the magnetite zone. The porphyrite was the only igneous rock observed in the area mapped.

OCCURRENCE OF THE MAGNETITE

Magnetite occurs in two parallel belts, conformable to the structure of the rock series, and, therefore, dips easterly 40 degrees to 55 degrees into the hill. It is found throughout a longitudinal distance of 310 feet, but is separated by drift into four principal exposures, varying in length from 34 to 104 feet, and in width up to 11 feet. The continuation of the zones is broken by a dip fault near the middle of the area and their depth has only been proved for 15 feet, as far as can be ascertained. Both foot-wall and hanging-wall are fractured and metamorphosed almost beyond recognition. There is no evidence of limestone along the side hill.

CHARACTER OF THE MAGNETITE

Only very small amounts of solid magnetite occur in this deposit. It is essentially a mixture of magnetite and garnet, and the garnet is either irregularly disseminated through the magnetite or occurs in a number of thin, elongated, lenticular, closely-spaced streaks that produce a marked banding in the deposit. This banding dips into the hill parallel to the walls of the lode, and is believed to be a relic of original tuffaceous bedding in the host rock (*Compare* Crown Prince, and Copper Island deposits).

ORIGIN OF THE DEPOSIT

The deposit is believed to have originated by the replacement of tuff or tuff-breccia beds between walls of rosette porphyrite, since the banded structure characteristic of tuff replacements is strongly evident here. The association and character of the magnetite suggest strongly a contact metamorphic origin, but sufficient areal field work was not done to enable the writer to point to the magmatic source of the replacing solutions. The porphyrite itself may have been the contributing agent, but, if so, it was at the same time rather intensely endomorphosed.

ECONOMIC CONSIDERATIONS

The following analyses, taken from the available literature, are quoted to make the description more complete.

—	A	B
Iron	55·9	50·96
Silica	16·0	.....
Sulphur	1·0	0·083
Insoluble	.....	25·95
Phosphorus	.....	0·00

A. Carmichael, H.: Bibliography, No. 6, "Average sample of the ore on the dump."
B. Lindeman, E.: Bibliography No. 16, "Average sample of the ore dump."

The deposit is too small, and the grade of magnetite too low to be of any value as an immediate source of iron ore.

Bibliography

See page 158 for further details

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16. Lindeman, E., p. 14.
17. Clapp, C. H., p. 189.
20. Lindeman, E., and Bolton, L. L., pp. 8-9.
21. Brewer, W. M., pp. 22-23.
22. Whittier, W. H., pp. 59-60.

(49 b) Defiance Deposit, Alberni Canal

(*See* Figure 39)

LOCATION

The deposit occurs near the headwaters of Handy creek, which enters Alberni canal on its west side about 2 miles from the entrance to Uchucklesit harbour. It may be reached in a distance of $1\frac{1}{4}$ miles by a good foot trail that leaves Alberni canal from a small bay about half a mile southwest of the Monitor mine landing.

The outcrops are located on relatively flat ground, constituting a rocky bench on the valley slope, at the foot of steep limestone bluffs. The elevation is about 1,000 feet (barometric) above sea-level; and the ground is drift-covered, heavily timbered with balsam and hemlock, and thickly overgrown with salal brush.

HISTORY AND OWNERSHIP

The Defiance and Defiance No. 1 mineral claim were located in April, 1902, by Messrs. Monie and Commoford of Alberni (6, pages 213-214). Brewer (21, page 21) states in 1916 that these two claims are Crown-granted and belong to Michael Commoford of Alberni.

GEOLOGY

Hornblende diorite (Beale) occurs here in intrusive relations with respect to a large body of fine-grained, greyish limestone (Nitinat) containing nests and stringers of calcite and siderite. Both rocks are altered in the vicinity of the contact zone; the diorite to a fine-grained, chert-like porphyritic phase, and the limestone to masses of garnet, epidote, and quartz. In the two tunnels and in the cliffs to the northwest of the cabin, the limestone can be plainly observed to be nearly flat-lying, with local dips up to 10 degrees or 15 degrees, and to lap over the intrusive. Roof pendants of altered limestone (garnet, etc.) occur within the diorite strung out in a northeast-southwest direction. Manifestly, the diorite exposed in this area is the top of the intrusive body that is just barely unroofed by the erosion of overlying limestone. In this respect the geology of this deposit is somewhat similar to that of the Sarita River magnetite, and also to that of the Glengarry-Stormont area, Nootka sound, to be discussed later.

OCCURRENCE OF THE MAGNETITE

Magnetite occurs in a number of isolated pockets and lenses, strung out in a northeast-southwest direction through a total distance of 770 feet. The main part of the prospecting has been carried out over 400 feet of this distance, and at a distance of 370 feet to the southwest the last isolated deposit is found. The largest exposure of the better grade of magnetite measures about 350 square feet in area, and the size of the remaining ones is very much smaller. Elongated patches of rocky magnetite (magnetite mixed with a large quantity of contact metamorphosed rock) up to 35 feet in length and 9 feet in diameter occur, but these also are disconnected. Most of these outcrops are bounded by drift, so that the relations of the individual occurrences are not clear, and their actual sizes may be greater than their outcrops.

The western of the two tunnels crosses a contact between diorite and limestone, but exposes only a small mass of magnetite in a drift to the east. This tunnel demonstrates the lack of continuation between the magnetite exposure 30 feet west of its portal, and the exposures around the eastern tunnel.

CHARACTER OF THE MAGNETITE

Very little high-grade magnetite was seen either in place or on the dumps. Most of it is intimately mixed with garnet, siderite, and calcite; some of it is richly impregnated with chalcopyrite in grains and stringers.

ORIGIN OF THE DEPOSIT

The magnetite is clearly of contact metamorphic origin, and is the result of the replacement of small elongated roof pendants of limestone in the diorite, by the action of iron-bearing solutions derived from the intrusive. The actual underground extent of these replacements has not been determined, but there is nothing to indicate that they are of large size.

ECONOMIC CONSIDERATIONS

The deposit is developed by considerable stripping, and open-cutting, and by two tunnels, 100 feet and 35 feet in total length.

There are two selected analyses published by Lindeman and Brewer, which are here quoted, simply to complete the descriptions.

—	A	B	C
Iron	66·89	52·6	66·0
Phosphorus	0·024	nil	nil
Sulphur	0·060	4·2	trace
Insoluble	4·37	12·1	3·3
Copper	.....	3·3	.....

A. Lindeman, E.: Bibliography, No. 16, "average sample."
B. Brewer, W. M.: Bibliography, No. 21, sample of ore from tunnel No. 2.
C. Ditto, "average sample from a large dump at the portal," tunnel No. 1.

The deposit is of no value as an immediate source of iron ore.

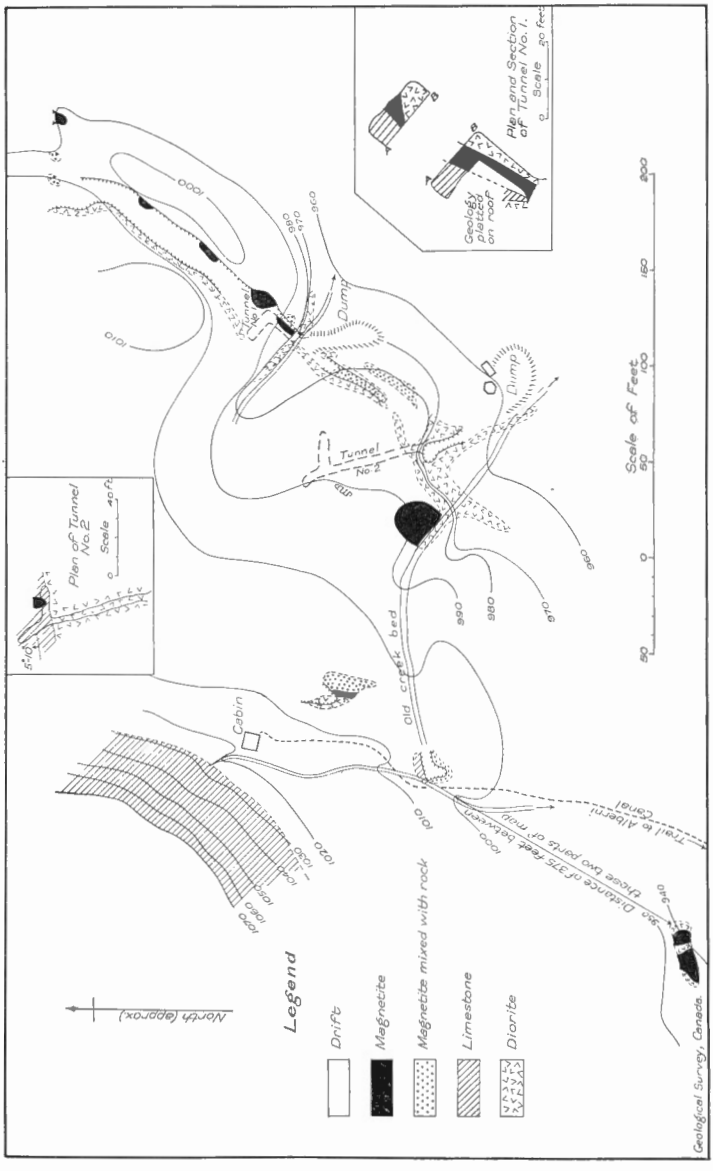

Figure 39. Magnetite deposit, Defiance claim, Handy creek, Alberni canal, Vancouver island, B.C. Contour interval, 10 feet.

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See page 158 for further details

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21. Brewer, W. M., pp. 21-22.
22. Whittier, W. H.
29. Ann. Rept., 1902, p. 230; Ann. Rept., 1908, p. 143.

(50 a) Magnetic No. 1, Henderson Lake

(*See* Figure 40)

Henderson lake, about 9 miles in length, empties through a narrow stream into Uchucklesit harbour, at the entrance to Alberni canal; and the Magnetic No. 1 mineral claim lies on the southwest side of the lake, and about 2 miles from its upper end. This claim was originally the Iron Mountain, and was first staked about 1901, but was allowed to lapse. Since then it has been staked and abandoned several times until the summer of 1916, when it was restaked by Anthony Watson, of Port Alberni, who has since done some open-cutting (21, page 19).

Magnetite occurs along the southeast bank of a small creek tributary to Henderson lake, and about 300 feet inland from the lake, at altitudes of 250 to 300 feet above sea-level. The bank is well timbered, steep, and covered with underbrush and moss, so that rock relations are obscure. Three small isolated bodies of magnetite, and of magnetite mixed with garnet, epidote, etc., were found throughout a longitudinal distance of 120 feet; and the largest of these is 75 feet long with a maximum width of 20 feet. There is no evidence pointing to the continuity of these three bodies. The principal deposit seems to dip southeasterly into the hill-side, but its outlines are not well enough defined to establish this point.

Country rocks are weathered and considerably rotted by percolating water, making difficult their identification, but below the deposit in a downstream or northeasterly direction hornblende diorite appears and is abundantly exposed along the shores of the lake. On the upstream side of the deposit, the rock appears to be silicified and silicated limestone. For some distance upstream this rock continues and is exposed in sharp cliffs along the banks, and in the stream bed are angular fragments of limestone containing bunches of quartz and lime-alumina silicates. It is inferred, therefore, that this deposit is also of contact metamorphic origin, occurring in limestone close to its contact with intrusive hornblende diorite.

The magnetite is hard, fine-grained, non-pyritiferous, but is impregnated with garnet, epidote, quartz, and some residual calcite.

This deposit constitutes an isolated occurrence, 10 miles distant from any other known ones, and being of a very limited extent is of no commercial value.

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See page 158 for further details

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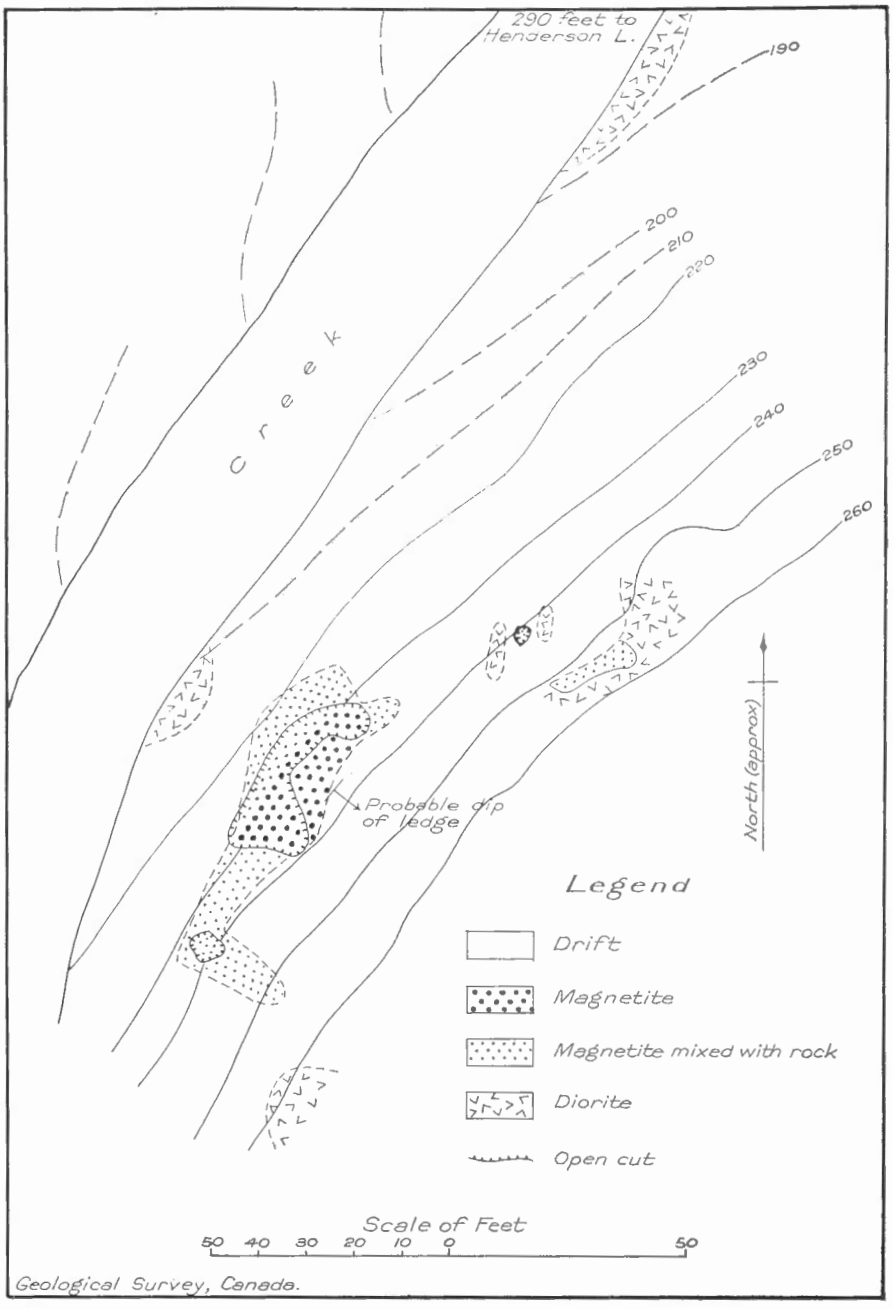

Figure 40. Magnetite deposit, Magnetic No. 1 claim, Henderson lake, Vancouver island, B.C. Contour interval, 10 feet.

(50 b) Black Prince No. 3, Uchucklesit Harbour

(*See* Figure 41)

Another small, isolated deposit of magnetite occurs on the Black Prince No. 3 claim, at an elevation of 2,000 feet (barometric) on the top of the mountain, about 1½ miles north-northeast of Kildonan, Uchucklesit harbour, and may be reached by a good trail leading from there. The summit of the mountain in the vicinity of the claim is somewhat flat (drift-covered) and is clothed with balsam, hemlock, and moss.

The Black Prince No. 3 is a claim of record, belonging to James Wilkenson of Alberni, and the required assessment work is carried out from year to year.

Six separate masses of pure and rocky magnetite occur throughout a longitudinal extent of 200 feet in a northeasterly direction, but the largest of these individual masses has an exposure of only 250 square feet (Figure 41). They are of irregular shape and occur in association with a fine-grained, cherty, porphyritic andesite or andesitic tuff, near its contact with intrusive hornblende diorite. Two bodies of high-grade, lustrous, granular magnetite occur. These are strongly sheeted, with sheets from 1½ to 2 inches thick, have a sugary texture, and in many places possess polarity (lodestone). Some of this solid variety is tarnished blue by copper minerals, and has the closely spaced joints filled with veins of pyrite. The more impure masses are intimately mixed with porphyrite or occur as veinlets in it, and contain disseminated garnet.

There is no evidence of limestone on the claim, although at a distance of several hundred feet down hill towards Kildonan, and continuing from there to the shore are extensive exposures of massive grey limestone. It is just possible, however, that the slight depression between rims of diorite trending southwest from the main showing is underlain by limestone, and that such an inclusion of limestone is replaced by magnetite and cinnamon-coloured garnet. It seems more plausible to consider that the porphyrite belongs to the Vancouver series, and that veinlike masses and irregular bodies of magnetite have been deposited in it, by contact action of the Beale diorite.

Two small open-cuts constitute the development work, but they do not assist materially in proving continuity of the magnetite. No estimate of tonnage can be made, and the deposit is of no commercial value.

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See page 158 for further details

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29. Ann. Rept., 1910, p. 151.

(50 c) Sunshine Group, Uchucklesit Harbour

Another small deposit of magnetite occurs on the Fern claim, of the Sunshine group, located on Cascade creek, which flows into Uchucklesit harbour at Kildonan (Wallace Fisheries plant). The showings are about three-quarters of a mile north-northeast of Kildonan, at an elevation of approximately 700 feet above sea-level (barometric), and they may be reached by the trail leading to the Black Prince No. 3, which passes by the side of one of the outcrops.

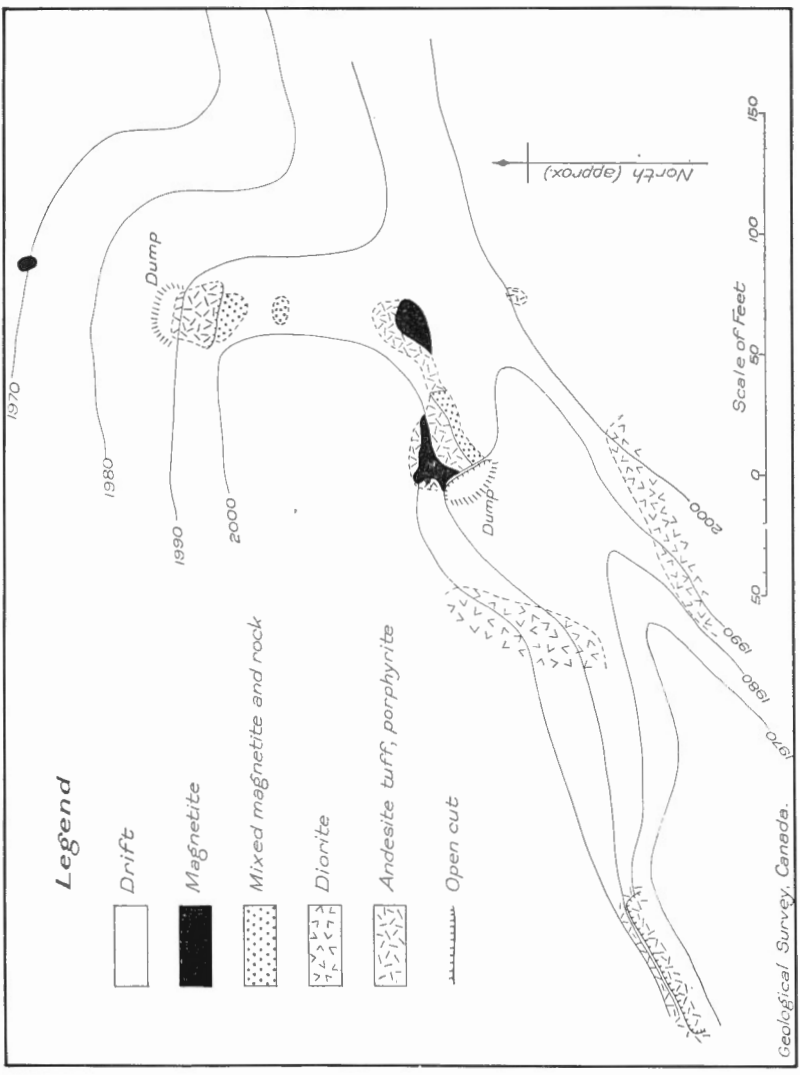

Figure 41. Magnetite deposit, Black Prince No. 3 claim, Uchucklesit harbour, Barkley sound, Vancouver island, B.C. Contour interval, 10 feet.

There are five small outcrops of magnetite and one of mixed magnetite and micaceous hematite, but taken altogether they were not considered of sufficient importance to warrant detailed description and mapping. The following notes are, however, given, since they are of scientific interest.

The deposits occur along the steep sides and in the gorge of Cascade creek, where the creek makes two cascades. The valley slopes are clothed with hemlock, balsam, and a few Douglas fir. Beale diorite is in intrusive relations with andesite (lava, tuff, and breccia of the Vancouver series) and limestone (Nitinat formation), and has altered the limestone to masses of garnet and epidote, whereas the andesite is much fractured and metamorphosed to a type containing bunches and stringers of epidote and garnet, and in places thinly interbanded garnet and tremolite. Higher up the mountain, the rocks are chiefly diorite, and from here to the shore massive limestone is predominant.

Small, lenticular bodies of magnetite occur in the contact altered limestone as shown at the portals of the two tunnels, and elsewhere, but the largest of these is about 25 feet long and 5 feet wide. Other irregular-shaped masses of very impure rocky magnetite, impregnated with considerable pyrite and chalcopyrite, occur in places; vein-like stringers and layers of magnetite grains produce a strikingly banded appearance in some parts of the altered andesite, a structure which is probably due to the replacement of thinly-bedded andesitic tuff. In detail, these vein-like stringers of magnetite are in the shape of flat lenses, similar to the occurrence on Copper island, except that they are much smaller, and carry considerable pyrite along their margins. The andesite along these margins is altered to a mixture of garnet and epidote.

Along the trail, and 150 feet southwest of the upper cascade is a small lenticular mass of high-grade magnetite (4 feet $\times$ 3 feet $\times$ 4 feet high) enclosed by contact metamorphosed limestone, and showing no continuation. It is of the variety lodestone and possesses strong polarity.

On the north side of the creek, where the latter takes a sharp bend to the north, and 50 feet from the shore, is a showing of micaceous hematite associated with magnetite, and thinly interbanded garnet and tremolite. This showing is exposed only for a few feet up the bluff, and is about 2 feet in width. Another small outcrop of the same kind was observed about 300 feet farther east, along the line of the flume to the Wallace fisheries plant.

On the Fern claim, therefore, both magnetite and hematite are developed, as replacements of limestone and andesite, but only in such small amounts (as far as surface indications go) as to render the property of no value as a source of iron ore.

The group is recorded (1925) in the name of L. Manson, Nanaimo, B.C.

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CLAYOQUOT MINING DIVISION

(51 a) Kennedy Lake District, Clayoquot Sound

Deposits of magnetite are known to occur in the mountains north of the head of Kennedy lake (east arm), but owing to bad weather and failure to obtain a guide who could conduct the party to the showings, the investigation of them was abandoned. The following description by Brewer (21, pages 23-24) indicates that, as they stand, the deposits have no value as an immediate source of iron ore.

"Iron Mountain and Chieftain: These mineral claims are owned by Mrs. W. T. Dawley, of Clayoquot, and were originally staked because of the discovery of a vein of gold-bearing quartz. Magnetite deposits of the contact-metamorphic type occur about 3 miles northward from the head of Kennedy lake, and 12 miles northwestward, in an air-line, from the deposit near the head of Henderson lake. This section is very mountainous, cut by deep, precipitous gorges which are the beds of creeks. One of these creeks heads at an elevation of about 2,700 feet above sea-level and flows through deep canyons. The lowest occurrence of magnetite seen by the writer is an outcropping in the steep bank of the creek, at an elevation of about 1,800 feet, on the Chieftain claim. The exposure of magnetite is about 20 feet long, but whether this is along the strike or across the body cannot be determined until some work is done.

"An average sample of the outcrop assayed:

	Per cent
Iron	30·10
Sulphur	0·31
Phosphorus	Trace
Silica	51·5

"This outcropping occurs under a limestone bluff, and overlies an igneous rock. Some development work is said to have been done farther up the creek on the opposite side, but the guide with the writer was unable to locate it because of the great growth of bushes and lack of a trail.

"Outcroppings of magnetite occur at several points on the sides of steep ravines farther up the same creek, but no work has been done, and as the slopes are almost perpendicular, too steep to climb, no examination could be made.

"The mineral claims were staked originally because of the occurrence of gold-bearing quartz at an elevation of 2,400 feet above sea-level, which has been prospected by an adit.

"The Iron Mountain mineral claim adjoins the Chieftain on the north and occupies a part of the summit of the mountain about 1,000 feet higher elevation, where outcroppings of magnetite occur that need development work before any estimate can be made as to extent."

Lindeman (16, page 16) reports an analysis of a sample of magnetite from this group as follows:

	Per cent
Insoluble matter	7·64
Iron	63·07
Phosphorus	0·016
Sulphur	0·043

(51 b-52) Other Clayoquot Sound Deposits

A few other minor occurrences are known in the country tributary to Clayoquot sound, but these are too unimportant to warrant detailed description. These are on: (1) the Hetty Green group, 1½ miles above the mouth of Deer creek, where there is reported (6, page 788) to be a "12-foot open-cut . . . . (in) an outcropping, about 20 feet wide, of magnetite, largely mixed with calcite gangue matter and igneous country rock, and carrying a small percentage of copper pyrites"; (2) the Ormond claim, Matilda creek, Ahousat, from which a few feet of magnetite is reported (6, pages 187-188); and (3) Beck's claim, near the north extremity of the peninsula separating Matilda creek or arm from the main part of the sound, where small exposures of impure magnetite occur in association with diorite and andesite or andesitic tuff.

(53) Hesquiat Lake Deposits

Two small deposits of magnetite are known to occur on opposite sides of Hesquiat lake, a narrow lake 3 miles long, trending a few degrees east of north and draining through a short gorge into Hesquiat harbour.

About 2 miles from the lower end of the lake a very noticeable contact between diorite and limestone crosses in a northwesterly direction, with diorite on the southwest, and limestone on the northeast, side.

The Violet mineral claim is located on this contact zone on the northwest side of the lake; the Agnes No. 1 and Agnes No. 2 mineral claims are similarly located on the southeast side. The Violet claim was located on June 6, 1902, by Jacobsen, but there has been no record of improvements since May 4, 1903. The Agnes claims were located by John Eik and Phillip Jacobsen on June 7, 1902, but no improvements have been recorded since June 8, 1903. All three claims have, therefore, lapsed to the Crown.

It was with some little difficulty that the showings on these claims were found in 1924, owing to the impossibility of finding guides and to the dense undergrowth and obliteration of trails. Searching in the limestone areas just beyond the above-mentioned contacts resulted in their rediscovery.

Neither of the deposits warrants detailed or accurate description.

VIOLET

The showing on the Violet claim is in a small gulch about 1,200 feet from the lake shore, at an elevation of 300 to 400 feet. Here an open-cut, 12 feet long, 3 to 4 feet high at the face, exposes magnetite streaked and spotted with garnet, occurring in a garnetized grey limestone. The magnetite zone is exposed intermittently for widths up to 12 feet and can be traced at intervals up the gulch from the 300 to the 400-foot contour.

AGNES NOS. 1 AND 2

The outcrops on these claims are on the southeast side of the lake and about 1 mile inland in a southeasterly direction from a small cabin located on the shore of a bay. Three small exposures of magnetite, mixed with epidote, garnet, and quartz were found along the steep banks of a small creek. Country rocks are diorite and a contact metamorphosed type made up of garnet with lesser amounts of epidote and quartz. A

bedding or laminated structure is visible both within this metamorphic type, and between magnetite and garnet. Magnetite bands have an average thickness of 1½ feet, and suggest a derivation by replacement of a bedded rock, such as a tuff. A tunnel 3 feet long is driven into a body of mixed magnetite and garnet, and a small amount of old open-cutting and stripping can still be observed. The largest exposure is a circular one surrounded by drift, and has an area of about 1,000 square feet in which very impure rocky magnetite occurs.

Neither of these deposits is of any commercial value.

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(54) Nootka Sound

(*See* Figure 42)

One of the largest groups of deposits of magnetite known near the west coast of Vancouver island occurs one mile from tidewater, near Head bay, at the north end of Tlupana arm. It covers parts of four mineral claims, divided between two ownerships, but the two sets of showings are so linked together geologically and areally, that they are both plotted on the same map. The Glengarry and Stormont constitute one group, and the Rob Roy and Prince Charlie the other.

(54 a) Glengarry-Stormont Group

LOCATION

These deposits occur on the ridge on the southwest side of the deep valley which is the northwesterly continuation of the Tlupana arm depression. The old trail to the showings which followed the valley is impassable owing to windfalls, so that present access is by a foot trail leaving Head bay and extending to the showings on the adjacent Rob Roy-Prince Charlie claims. From the No. 2 posts of the Glengarry and Stormont claims, which are on this trail, a blazed line leads northeasterly for about 700 feet to the bluff of magnetite.

The deposits are located on the nearly flat top and northeasterly slope of a prominent ridge trending northwesterly. The country is well timbered with hemlock, balsam, and cedar, but not very thickly covered with underbrush. The bluffs of magnetite near the northeast boundary are bare of timber in places, but are overgrown with light underbrush and moss. Glacial drift mantles all except the steep northeasterly slopes.

The showings are at elevations varying from 250 to 430 feet (barometric) above sea-level, and are well located for purposes of exploration and mining. The valley along the northeast edge of the deposits is a broad, open one and no difficulty would be experienced in making use of it for ore transport. The greatest depth beneath the exposures that could be obtained by means of tunnel development would be about 250 feet.

HISTORY AND OWNERSHIP

These claims were staked in 1902 by Clarence Dawley, of Clayoquot, William Poole, of Nootka, and Lachlan Grant. Some time afterwards, the owners interested Mr. William Sutton, geologist and mining engineer for the Dunsmuir interests, who made an examination of the claims and purchased on behalf of these interests the two-thirds share owned by Poole and Grant. When the Canadian Collieries (Dunsmuir) Limited took over the Dunsmuir coal mining properties about 1910, the iron ore deposits at Head bay were included, so that the claims are still in good standing in the names of the Canadian Collieries (Dunsmuir) Limited and Clarence Dawley. Three claims, Stormont, Glengarry, and Texas were Crown-granted in 1909.

GEOLOGY

The geology of these deposits is simple (*See* Figure 42). The area lies in the contact zone between an intrusive diorite and a thickly bedded, blue-grey limestone. Large exposures of the diorite are not observed on the claims, but occur along the trail to the beach, and along the shores of Head bay. As seen near the deposits the diorite is fine-grained and porphyritic, and in most cases is in dyke or sill form in the limestone. The longest exposure is at the base of the bluff of magnetite, and this may be part of a large plutonic body.

Limestone is the principal country rock; in some places it is markedly stratified, but in others this bedding structure is not easily apparent. There is a general northwesterly strike with a shallow dip (not over 45 degrees) to the southwest. Strike and dip faults are doubtless present, but they were not observed or mapped.

The idealized northeast-southwest cross-section, accompanying Figure 42, shows a probable interpretation of the structure, which in some respects is similar to that described for the Sarita and Copper Island deposits, Barkley sound. Underlying the dipping limestone, and with an undulating upper contact, is believed to be the main body of diorite, from which dyke and sill apophyses extend upwards and laterally into the limestone. The limestone ridge is, therefore, an uneroded portion of the roof of the diorite intrusion.

OCCURRENCE OF THE MAGNETITE

Magnetite occurs in a number of apparently isloated ledges in association with altered limestone, in many cases conforming in strike and dip with the limestone. The two cross-sections, through open-cuts B and C, Figure 42, show a well-marked dip from 20 degrees to 45 degrees into the hill, and in many of the exposures the bedding structure is preserved in detail in magnetite and garnet bands, or in adjacent bands of magnetite of different grain.

Outcrops of magnetite extend throughout a longitudinal distance of 1,860 feet in a northwest-southeast direction, and for 1,320 feet across the strike (including the showings on the Rob Roy and Prince Charlie claims). In many cases these outcrops are associated with garnet, and garnetized limestone; and when this mixture contains less than 70 per cent by volume of magnetite, the showing is classified and mapped as a magnetite-garnet mixture. Showings having a higher magnetite-garnet ratio than this are mapped as magnetite. Many of the outcrops show no geological relations

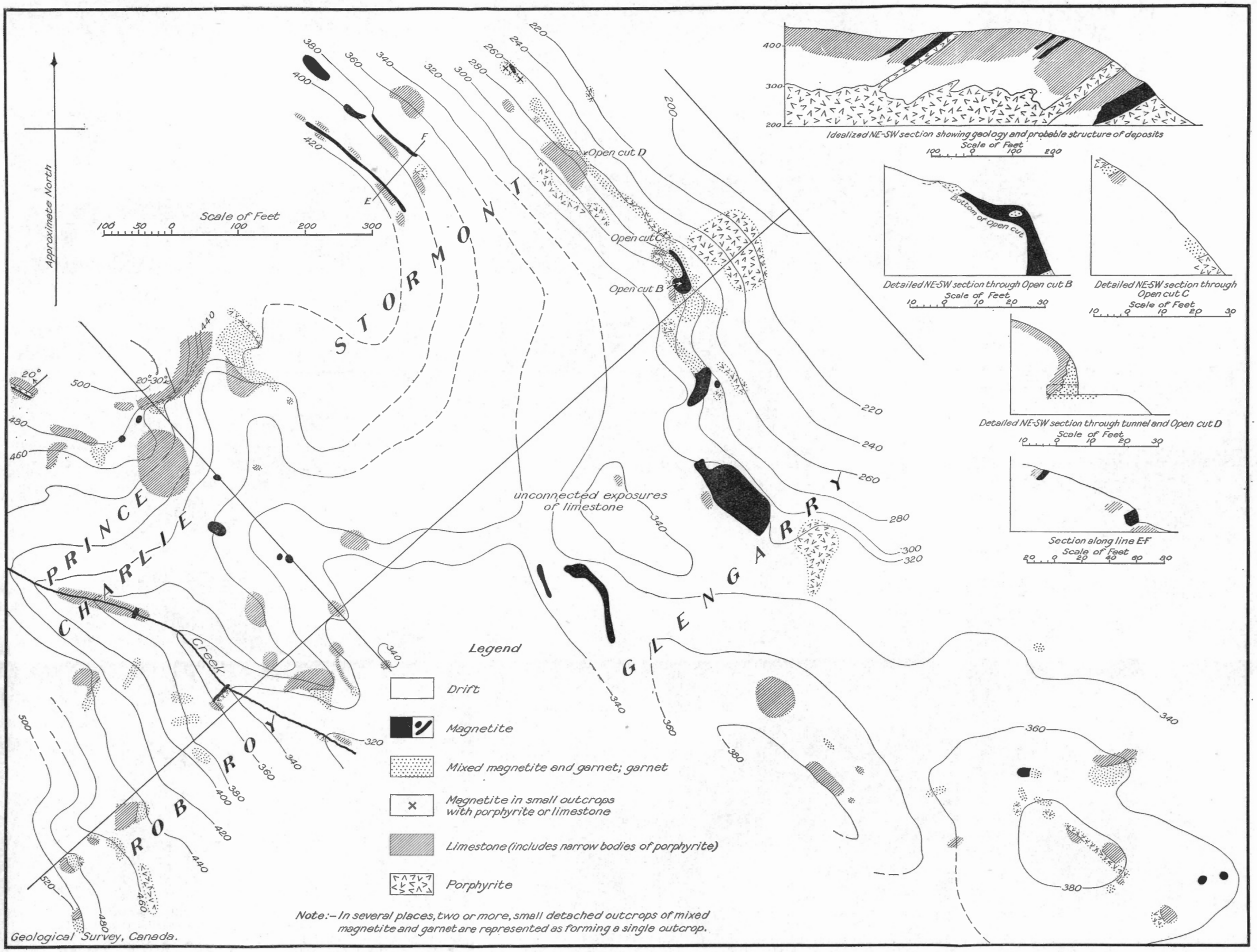

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Figure 42. Magnetite deposits, Glengarry-Stormont and Rob Roy-Prince Charlie claims, Nootka sound, Vancouver island, B.C. Contour interval, 20 feet.

as they are surrounded by glacial drift, but the magnetite ledges tend to be elongated parallel to the strike of the limestone, and to occur in three parallel northwesterly trending belts, an occurrence that is interpreted in the idealized cross-section.

In many places on the flat top of the ridge, angular fragments of magnetite up to a couple of hundred pounds in weight lie strewn along the surface in such a way as to suggest that they are in reality fractured outcrops. In addition, small bunches of magnetite occurring here and there within the limestone could not be mapped; and both of these facts point to a wider distribution of magnetite zones than is shown on Figure 42.

CHARACTER OF THE MAGNETITE

The magnetite is of high quality, medium-grained, steel-grey, hard, and flaggy; small amounts of it show polarity and are classed as lodestone. Most of it is mixed to some extent with light brown garnet and limestone, but in several outcrops the gangue is present in amounts less than 30 per cent by volume.

With the exception of a short stretch of outcrop northwest of open-cut B, where pyrite is abundant, sulphides are noticeably absent from these deposits, and very few of the outcrops are rusty.

ORIGIN OF THE DEPOSITS

The deposits are clearly of contact metamorphic origin, being the result of the replacement of inclined limestone beds by iron solutions derived presumably from the diorite. All the evidence points to a gradual replacement of tenuous solutions and not to an ore injection. On polished surfaces of the magnetite relics of limestone stratification can be seen. The common occurrence of isolated bunches and grains of magnetite in the limestone could not be effected by any other means than solutions of very high penetrating power. Lenticular dyke-like and sill-like masses of magnetite occur, but in these also the evidence for replacement can be observed.

In detail, the replacement seems to have taken place along well-defined stratigraphical horizons, in some cases adjacent to sills of diorite, and this leads to the inference that further exploration might lead to the establishment of a definite rule of occurrence that would be of the greatest value in estimating possibilities.

ECONOMIC CONSIDERATIONS

Extent of Deposit

As stated above, magnetite outcrops have been found at intervals throughout a longitudinal extent of 1,860 feet, and in at least three parallel zones. The longest continuous exposure is 435 feet along the face of the bluff, and the longest interval between known exposures is 450 feet. From the nature of the deposits, there seems to be no reason to suppose that the magnetite may not continue beyond these limits or that it may not also occur within the intervals. The difference in altitude between the highest and lowest outcrops on these claims is 175 feet, but this figure is based on the heights of different ledges. The greatest vertical exposure on any single ledge is along the face of the bluff, where mixed magnetite and garnet are seen from the 260 to the 310-foot contours. Owing to the character of

the occurrence as shown in the idealized cross-section, almost the entire surface of the two claims becomes good prospecting ground. It is not likely that any of the ledges will attain a great depth because of the probable occurrence of diorite in the core of the ridge, but this comparative shallowness may be compensated by a number of parallel ledges.

Analyses

The following analyses are taken from published descriptions of the deposits:

—	A	B	C
Iron	66·42	66·17	56·8
Phosphorus	.....	0·016	Trace
Sulphur	0·26	0·017	0·1
Silica	.....	.....	1·6
Insoluble	.....	8·04	.....

A. Carmichael, H.: Ann. Rept., Min. of Mines, B.C., 1906, p. 85. "Analyses of average sample."
B. Lindeman, E.: Bibliography, No. 16, "Average sample taken along the cut."
C. Brewer, W. M.: Bibliography, No. 21, "A general sample representing about an average of the deposits."

Development

The deposits suffer from lack of development and nature has done far more than man to demonstrate their size. There are a large number of old strippings that are now overgrown with moss or otherwise obscured; many old open-cuts of small size now partly caved; and one short tunnel driven into the hanging-wall of the bluff magnetite body, for a total distance of 10 feet.

Consequently not enough development has been done to permit an engineer to use a figure greater than 5 feet for the average depth of proved ore.

Tonnage Estimate

With an average assured depth of exposure of 5 feet, and an area of exposure of 13,600 square feet, one might estimate about 8,500 tons as proved ore. As the basis for an estimate of probable ore it is reasonable to suppose that these tabular bodies of magnetite will continue down the dip a distance equal to half of their exposed length. The magnetite contained within such dimensions (less the above figure for proved ore) would amount to approximately 51,500 tons (at 8 cubic feet per ton).

It is likewise possible that these deposits will either continue to vertical depths of at least 100 feet as an average, or, if one ledge lenses out another may come in so as to maintain the average; and the tonnage comprised within the volume represented by 100 feet of depth and present exposures, exclusive of probable ore above listed, would be 110,000 tons. Every additional 100 feet of depth would give 170,000 tons. No data are at hand to indicate the maximum depth of mineralization, but it would not be safe to extend the limits of possible ore below 100 feet of depth, unless further explorations should reveal new facts of occurrence.

To sum up, the following tonnage estimate is given:

	Tons	
Proved ore	8,500	
Probable ore	60,000	
Possible ore	110,000	(to depth of 100 feet)

Value of the Deposits

Of all the deposits examined near the west coast, these, on account of the surface extent of the showings, the comparative absence of sulphur, and the accessibility, are considered the most worthy of serious consideration as a possible economic basis for an iron mining industry. The property warrants additional exploration both by diamond drilling and by further surface and underground work.

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(54 b) Rob Roy-Prince Charlie Group

These two claims are also situated about one mile from Head bay, and they adjoin the Stormont-Glengarry group on the southwest, Figure 42. They are both claims of record located by William Poole and J. H. Gardhouse of Nootka, and cover the southwesterly extensions of the deposits on the Glengarry and Stormont claims. They supersede the Fido claim, which has lapsed.

The showings occur along both sides of a small creek, in timbered country, from elevations of 340 to 490 feet (barometric) above sea-level, and are reached by a trail from Head bay. Rock exposures are small and isolated, but the geological relationships are believed to be identical with those on the Stormont and Glengarry group. Dykes and sill-like masses of porphyritic diorite cut through greyish limestone, showing in places marked bedding dipping at 20 degrees to 30 degrees to the west.

Magnetite is exposed in many places, most commonly mixed with garnet and altered limestone, but in a few places in a nearly pure state. Exposures of it are all small, and no connexion between them and no general trend of an ore zone are visible.

The showings are believed to be parts of an irregular disconnected series of contact metamorphic replacements of limestone, by iron-bearing solutions that emanated from the underlying intrusive diorite.

No estimate of tonnage of magnetite can be made, and the only value the claims have is a highly speculative one that has for its sole basis the successful exploitation of the adjoining Stormont-Glengarry group.

References to these claims may be found in the bibliography of the Stormont-Glengarry group.

QUATSINO MINING DIVISION

(55-57) Quatsino Sound

(55 a) Iron Queen-High Gill Deposits, Ingersoll River

(*See* Figure 43)

LOCATION

Ingersoll river flows in a general northwesterly direction and enters Quatsino sound along its south shore, at a point opposite the western end of Limestone island; and these deposits are located about 5 miles from its mouth, high up on the southwestern valley slope. They are reached by a blazed trail that leads from the ranch operated by J. H. Browning (1924) through badly burnt and "slashed" country for half a mile and then follows along the west side of the river through heavy timber.

The exposures are in the beds and along the banks of two small creeks, tributary to Ingersoll river, and running parallel to each other at a distance of 300 feet apart. Their elevations are from 830 to 900 feet (barometric) above sea-level, and the banks of the river are here covered with a mantle of drift and clothed with hemlock, balsam, and cedar. Ingersoll river has a gradient of about 60 feet a mile, is from 50 to 100 feet wide, and flows through an open valley with one rock canyon below the claims.

OWNERSHIP

There are four claims—Iron Queen, High Gill, Iron King, Iron Bunker—recorded in the name of Frank G. Patterson, hand logger of Quatsino, and the necessary assessment work had been performed, keeping the claims in good standing (1924).

GEOLOGY

An igneous rock resembling monzonite, silicified andesite or andesitic tuff, and possibly altered limestone, are exposed in the immediate vicinity of the showings. In both creeks the andesite is much altered and replaced, and is doubtless cut by the monzonite, although this intrusive relationship cannot actually be observed. Around the larger deposit only the andesite is exposed. In both deposits, a structure dipping to the west or southwest is indicated.

OCCURRENCE OF THE MAGNETITE

Two ledges of magnetite occur, one in each creek, and both seem to dip westerly. The amount of dip of the larger body is uncertain, but it is probably quite steep. Judging from the geological relations, these seem to be two distinct ledges and not a single faulted one.

The smaller ledge lies immediately below an inclined contact with a medium-grained monzonite, and is 9 feet 6 inches from wall to wall (including a horse of andesite 2 to 3 feet thick). Lime-alumina silicates and calcite occur in the ledge, but there is no other indication of limestone. The magnetite is rusty-weathering and is spotted with grains and small bunches of pyrite. Unreplaced rock fragments are common in the ledge.

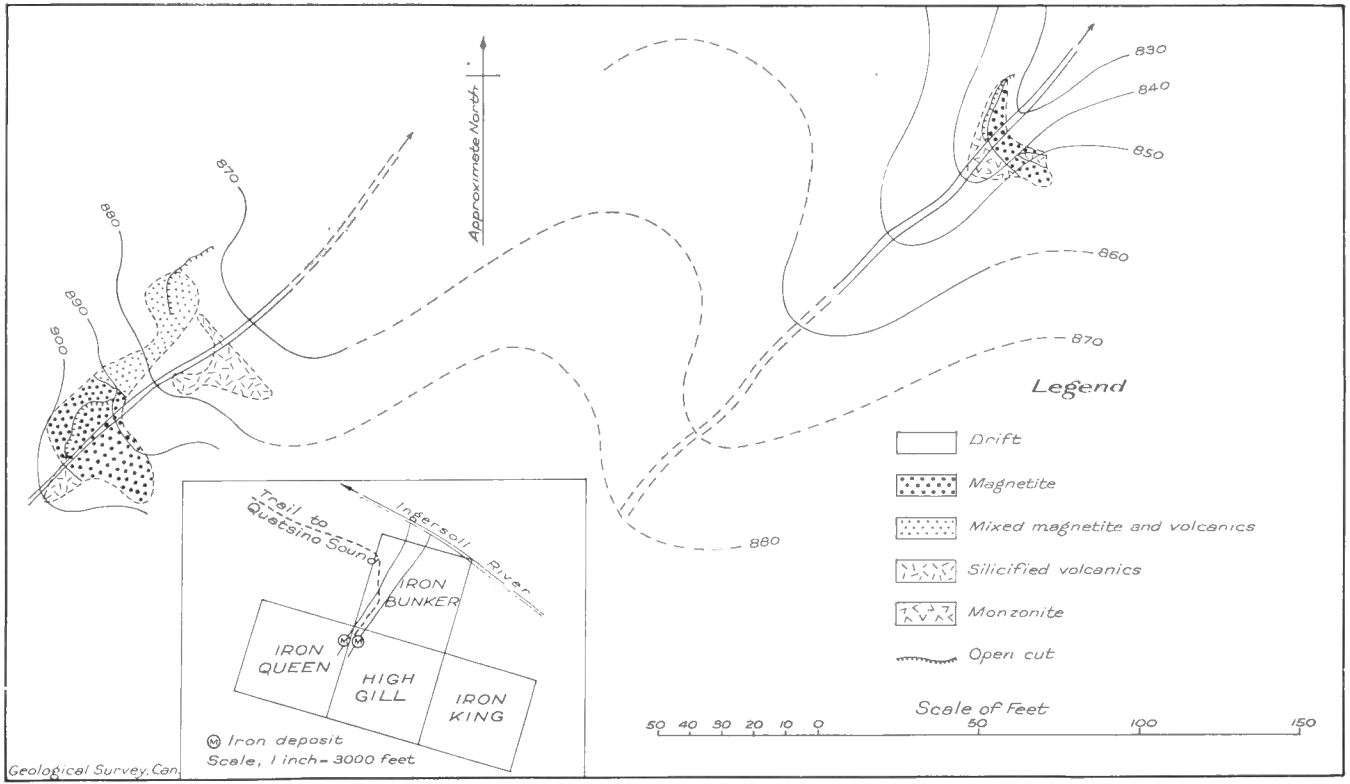

Figure 43. Magnetite deposits, Ingersoll river, Quatsino sound, Vancouver island, B.C. Contour interval, 10 feet.

The larger ledge is bounded on its east and southwest sides by a fine-grained siliceous rock resembling an andesite or andesitic tuff, and grades into this rock. No other geological relationships were observed, all other boundaries being drift-covered. It is probable that the ledge trends northwest-southeast and dips westerly.

CHARACTER OF THE MAGNETITE

The area outlined as underlain by magnetite consists of 80 to 90 per cent magnetite by volume, whereas the area mapped as mixed magnetite and volcanics contains about 50 per cent by volume of each.

The magnetite itself is dense, hard, greyish black to bluish black and is impregnated with small amounts of pyrite. The unreplaced andesite mixed with it carries abundant finely disseminated pyrite. As this deposit is to a large extent covered by moss, it is impracticable to make a reliable statement regarding the grade.

ORIGIN OF THE DEPOSITS

The magnetite appears to be a replacement, under contact metamorphic conditions, of the volcanic rocks in the vicinity of the intrusive contact with the monzonite. Replacement bunches and veinlets of magnetite occur in the brecciated and silicified volcanic rocks, and in one exposure magnetite was found containing unreplaced laths of plagioclase feldspar, indicating that at least part of the ledge resulted from the replacement of tuffaceous andesite porphyrite.

The usual supply of garnet, epidote, etc., so common in the other deposits, is almost entirely lacking (especially in the larger or westerly body). Limestone is reported to occur on another part of the claims, but none was seen near the showings.

ECONOMIC CONSIDERATIONS

Neither of these deposits can be considered as immediate sources of iron ore, both on account of their lack of development and distance from tidewater. The easterly deposit is too small and too sulphurous in character. The westerly or larger deposit contains some magnetite (of good grade), and if it should prove, on further exploration, to have a northerly trend, as indicated on the map, and a fairly steep dip, a body of magnetite of a width of at least 40 feet might be opened up. There are no rock exposures to the north or south of the showing to interfere with, or suggest extension, so the value of the deposit becomes highly speculative.

(55 b) Other Ingersoll River Deposits

Another deposit containing magnetite was located in May, 1902, on Ingersoll river, about half a mile from its mouth, and on its east side several hundred feet above water-level. A small amount of work was done on this showing prior to 1907, and after that there is no recording of further development. The property was known as the Blue Bird group, consisting of the Blue Bird, Mystic, Ingersoll, Stella, and Olga claims. "The ore was magnetic carrying gold values. A tunnel was run in 30 feet,

tapping the lead at 40 feet depth and showing the same class of ore, whereas copper was expected to be found" (29).

The deposit is evidently of no value as an immediate source of iron ore.

Bibliography

See page 158 for further details

29. Ann. Rept., 1903, p. 194; Ann. Rept., 1907, p. 199.

(56) June Deposit, Quatsino Sound

(*See* Figure 44)

LOCATION

The June group, consisting of five Crown-granted mineral claims, is located on an easterly-facing slope leading down to Alice and Victoria lakes, and is from 4 to 6 miles east of June landing, on the southeast arm of Quatsino sound. The workings may be reached by a good pack trail from June landing, over which all the supplies are hauled for the Coast Copper Company's operations at the Old Sport mine. The magnetite showings are only 200 yards southeast of the trail, mainly on the June claim. The tunnel and dump may be seen from the trail by looking southerly across June creek.

The deposit occurs in thickly timbered country with dense underbrush, and many of the old workings are obscured by a second growth of evergreens. They are on a gentle slope facing June creek to the northwest, and have elevations varying between 490 feet (portal of tunnel) and 630 feet above sea-level. Rock exposures are few except on top of the knoll at the southwest where an old quarry reveals some geological relationships.

HISTORY AND OWNERSHIP

This group contains the Amazon, Helen, June, Olga, and Iron Knob claims, owned by the Copper Mountain Mining and Development Company of Tacoma, U.S.A., which were located in 1901 and 1902 as a copper prospect. The tunnel was driven several years ago in the hope of intersecting the body of magnetite and bornite exposed in the large open-cut, but as this was unsuccessful, development was abandoned. In 1916, N. S. Clarke and associates of Seattle took a bond on the property and prospected other parts of the ground, mainly for copper. Since that time no further work has been done.

GEOLOGY

Hornblende diorite, andesite, andesitic tuff, and limestone are all exposed in the vicinity of the magnetite showings, but the geological relationships between these rocks were not definitely determined. Limestone was only found in one exposure on a cliff face where it is silicified and in vertical contact with diorite. Nests of crystalline calcite and grains of galena are scattered through the limestone. The contacts between the diorite and the volcanic rocks within the tunnel were well-marked, and appear to be intrusive in character. It seems probable that the diorite occurs as a number of parallel dykes or sills in the andesites and tuffs,

but evidences of stratification in the latter were not found. A more acidic intrusive, probably granodiorite, is exposed a few hundred yards from the showings, but its relation to the diorite was not ascertained.

OCCURRENCE OF THE MAGNETITE

Magnetite is found in two different occurrences in this deposit, as vein-like masses and irregular replacements in the volcanic rocks, and as veins, small masses, and spotty impregnations in the diorite. The outcrops extend over a longitudinal distance of 400 feet. Only three small exposures of it were found in the tunnel, but it is interesting to note that no magnetite was found near the face of the tunnel which lies 120 feet underneath the bluff exposure. No structure is visible within the magnetite exposed on the bluff, and the contact seen on its western face between magnetite and diorite is by no means a definite one, as there is a gradation between solid magnetite on the north, through small, irregular-shaped masses to veinlets and scattered grains to the south. These veins, consisting of quartz with chalcopyrite, bornite, and magnetite (the latter mainly in the diorite walls), have a steep northerly dip, giving a pseudogneissic appearance to the diorite, and suggesting a nearly vertical structure. On the other hand, this apparent vertical structure does not extend downward to the tunnel level, and there is no other feature of the whole deposit indicating a vertical attitude. Within the tunnel immediately northwest of the first bend, there occurs a stringer or layer-like deposit of magnetite exposed in both walls in nearly horizontal attitude, with a slight dip into the tunnel. It is mixed with garnet, pyrite, and pyrrhotite, is about 30 feet in length, and varies in thickness from 6 to 18 inches. Whether this has any relationship to the structure of the deposit is not certain, but it might be suggested that a shallow dip of the volcanic rocks to the east or southeast might explain the occurrence of this tabular mass, as well as account for the absence of magnetite in the face of the tunnel.

CHARACTER OF THE MAGNETITE

Only very small amounts of solid magnetite are exposed in this deposit. Most of it is badly mixed with garnet, tremolite, actinolite, pyrite, pyrrhotite, and altered volcanic rocks; the remainder is scattered through the diorite, and associated with quartz stringers containing chalcopyrite and bornite.

ORIGIN OF THE DEPOSIT

The magnetite is a replacement of the volcanic rocks and of the diorite, manifestly by tenuous solutions that attacked the ferromagnesian minerals in preference to, and before, the others. The deposit does not seem to have the usual characteristics of the contact metamorphic type, and it seems strange that a mass of limestone, so close by, should have escaped replacement. The copper mineralization was at a later stage, following quite clearly the deposition of magnetite.

The source of the solutions is not known. There may be two generations of magnetite—one in the volcanics due to the influence of the diorite dykes or sills, and another in these intrusives, due to the influence of larger masses of diorite elsewhere or at greater depth. It is also possible that all the magnetite may be of one generation, supplied by emanations from

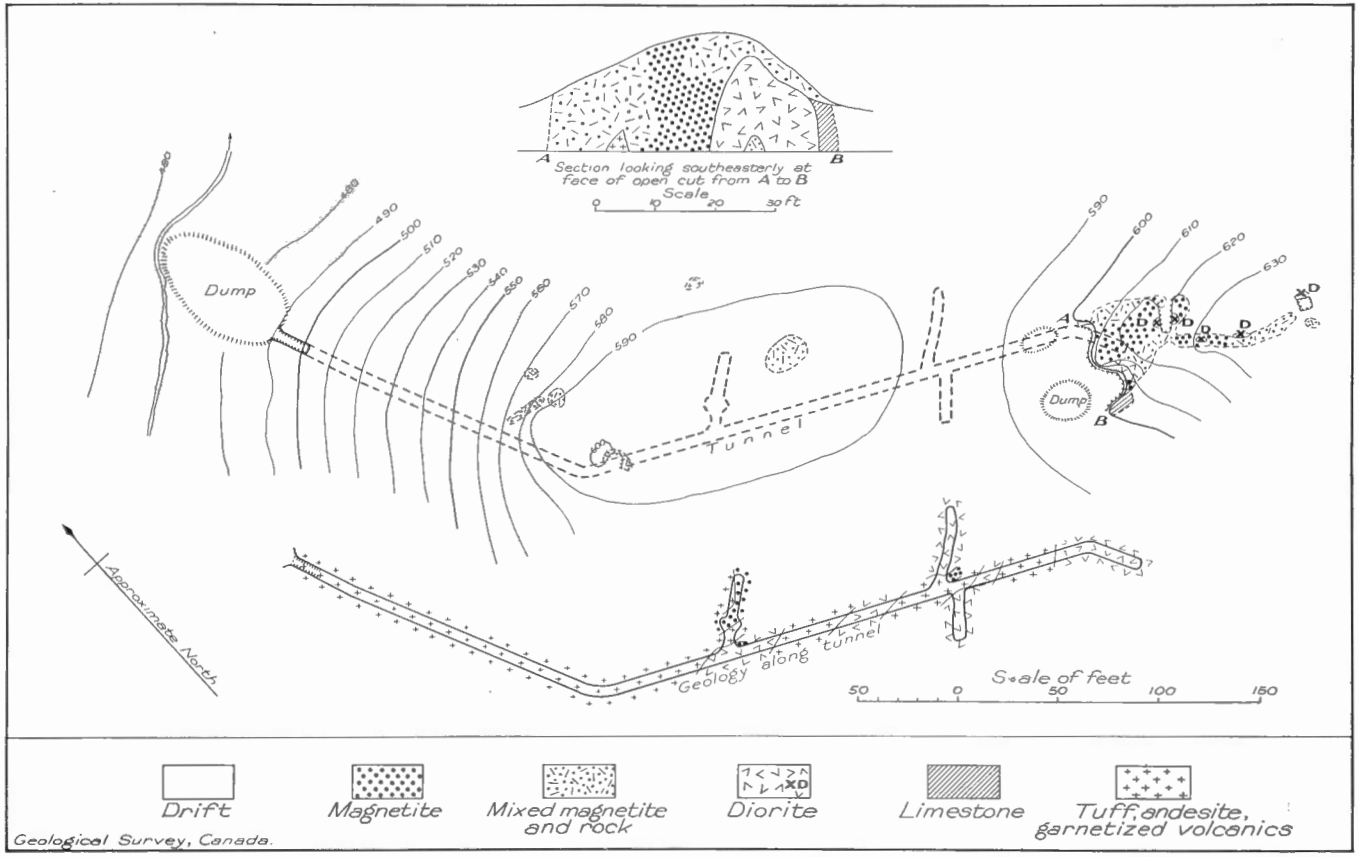

Figure 44. Magnetite deposit, June group, Southeast arm, Quatsino sound, Vancouver island, B.C. Contour interval, 10 feet.

an underlying or nearby large-scale diorite stock. The copper mineralization may owe its origin to the granodiorite intrusive mentioned above as occurring some distance from the deposit.

ECONOMIC CONSIDERATIONS

This deposit is not of economic value primarily as a source of iron ore, although a small tonnage of magnetite might be obtained from the mining and treatment of the deposit for its copper values.

Bibliography

See page 158 for further details

29. Ann. Repts., Minister of Mines, B.C., 1903, pp. 194-195, 201; 1916, pp. 341-342.

(57) Limonite Deposits, West Arm, Quatsino Sound

Two deposits of bog limonite, occurring on the north side of the west arm of Quatsino sound, were briefly examined, but very little new information of value was derived, beyond what has previously been published in the annual reports of the Minister of Mines for British Columbia.

(57 a) Lot 321, "Quatsino Iron Ore"

LOCATION

This deposit is located about one mile west of the west end of section 1 of the Coal Harbour Land Grant, on the slope of a hill facing southwest, and about one-quarter of a mile from the west arm. It is probably located on lot 321, township 19, but is mentioned by Carmichael as being on "Section 26".

The hill-side on which the deposit occurs slopes about 20 degrees down to the valley of a small creek, and is well timbered, except over an old stripping which is now partly obscured by young hemlocks.

HISTORY AND OWNERSHIP

Brewer states that these claims "were sold to the Moore Investment Company, of Seattle, which operated the blast-furnace at Irondale, in the state of Washington, for a few months, and some shipments of this bog-ore were made, but since that enterprise failed the mineral claims have reverted to the Metropolitan Trust Company, of New York, which acquired the assets of the original purchasers" (21, page 28).

Robertson in 1907 makes the following statement, which is quoted by Brewer: "To extract this ore the Moore Investment Company had, earlier in the year, sent up a large force of men on an ore-barge, and had built a temporary wharf from which a tramway was built to the iron-ore deposit. In August the property was found to have been abandoned, the track torn up, and the rails shipped away. From the workings visible it would appear that the iron deposit over an area 300 feet long and 200 feet wide had been removed from the surface down to solid bedrock, and this area had yielded 1,500 tons of ore, which had been shipped." [1]

[1] Robertson, W. F.: Ann. Rept., Minister of Mines, 1907, p. 149.

GEOLOGY

The hill-side is underlain by a fine-grained, bleached, softened, light-coloured rock, seemingly igneous in origin, richly impregnated with very fine-grained pyrite. Glacial drift covers the hill-side to a depth of a few feet.

OCCURRENCE OF THE LIMONITE

The limonite lies on top of a glaciated rock surface, and occurs within the mantle of drift underneath the grass roots. The bedrock itself is very rusty and rotten, and the limonite does not break free from it. It is a porous, cellular, dry, brittle gossan, with transported limonite deposited in the cavities. It is yellowish to dark brown in colour, and contains vegetable matter with boulders and fragments of the rocks of the drift. The deposit, as observed in the old stripping, varies from a few inches to 4 feet in thickness.

ORIGIN OF THE DEPOSIT

The deposit consists of residual and transported limonite, occurring within and cementing and replacing the glacial drift, and the upper 2 or 3 inches of bedrock. The iron is evidently derived from the oxidation of the fine-grained pyrite, part of whose oxidation products are fixed as cellular limonite, whereas another part was transported in solution a short distance only to be deposited in cavities in drift, and as a replacement of the vegetable remains and the drift itself. In places, the rock fragments in the drift are themselves replaced by limonite.

ECONOMIC CONSIDERATIONS

The country is thickly timbered, so that it is impossible to ascertain anything about the extent of this partly worked deposit or about the possible occurrence of other similar ones. It does not appear that limonite deposits of large size, similar to this one, are to be found on this side hill.

Bibliography

See page 158 for further details

21. Brewer, W. M., p. 29.
22. Whittier, W. H.
29. Ann. Rept., 1907, p. 149.

(57 b) "Prince's Iron Claims"

LOCATION

These claims, of which there were thirty-six, are located on the north side of the west arm of Quatsino sound, about 8 miles west of the entrance to Coal harbour. They are on both sides of the boundary line between townships 19 and 25, and extend from a point half a mile back from the shore to a distance of 2 miles back. The group is outlined on Reference Map 3 D of the Department of Lands, Victoria, B.C.

The old trails to this deposit are obliterated, particularly near the shore, due to logging operations, but after the standing timber is reached there are a number of poorly preserved trails, leading in several directions to different parts of the deposit.

The deposits are located along the lower slopes of hill-sides and as bogs in the vicinity of small creeks. In the flat or typical bog parts of the deposits, timber is almost entirely absent, and the ground is covered with grass and scrubby second growth evergreens. On the hill-side deposits, however, where the slopes rise to 15 degrees, the timber is thick, and some of the trees are over one foot in diameter. As far as could be ascertained, there are no topographical features that give a clue to the outlines of the deposits.

A number of small creeks flow through the claims, and they are all depositing flocculent iron hydrate. The elevation of the deposits varies from 200 to 400 feet above sea-level.

HISTORY AND OWNERSHIP

The following details are quoted from previous publications:

"A group of thirteen claims was recorded during the past summer and is now held by the Iron Mountain Syndicate of Victoria; little or no development work, however, has been done as yet" (6, page 206).

"The thirteen claims owned by Messrs. Frank, Croft, and others on the West arm have received some development work this year (1903) . . . The property consists of eight claims containing limonite, and five containing bog iron. . . . The bogs are drained by a small creek flowing into the arm and named Indian creek. These deposits have been prospected by holes sunk at different points. On a range of hills to the northwest of the bogs lie the limonite deposits, one of which, on the Sunrise claim, one mile back from salt water and at an altitude of 400 feet, was examined. . . . The deposit has also been prospected by a number of open-cuts and holes" (29, pages 195, 202-203).

"The original twenty-two claims . . . were sold to J. Moore of Seattle. . . . . A large number of open trenches have been dug systematically. . . . The owners . . . . have just acquired the balance of the new locations made this year (1905), numbering some fourteen claims" (29, pages 212-213).

Thirty-six claims on the north side of the arm are owned by J. A. Moore and W. Pigott of Seattle. On the thirty-six claim area, considerable work was done in 1906. "The two largest cuts are 425 feet long, 4½ feet wide, 7 feet deep; and 200 feet long, 2 feet wide, and 4 feet deep, all in ore. Some of the shafts are sunk 14 feet deep (29, pages 183, 201).

GEOLOGY

Owing to the caved and overgrown condition of the old workings and the dense cover of underbrush and timber, very little new information was obtained in 1924, so that some data is quoted from earlier reports.

The country rock on the hill-sides over which the tributary creeks flow is a fine-grained, soft, decomposed, light-coloured intrusive or extrusive, richly impregnated with fine-grained pyrite. No rock relations were discovered.

OCCURRENCE OF THE LIMONITE

Iron hydrate (here loosely called limonite) occurs as an undulating blanket paralleling the present surface and is found in the following way: (a) as a cement in the glacial drift; (b) as a replacement of pebbles and

sand in the drift; (c) as cellular, gritty, honeycombed masses; (d) as a replacement of vegetation; and (e) as a flocculent gelatinous scum in suspension in the creeks and as a newly formed deposit at their margins.

Several of the old trenches were dug out and their sides cleaned up for examination, and the following details of occurrence noted. One trench showed along its side, measured from the surface down, 4 to 6 inches of surface mould, 18 inches of yellowish glacial drift with rock fragments cemented by limonite, 12 inches of indurated limonite consisting largely of replaced vegetation or peat, 10 inches of soft, wet, yellowish, clayey limonite, followed by hard, gritty, blackish, sandy drift.

Another trench 6 feet high at the face, shows at the bottom 3 feet 6 inches of indurated, porous, cellular limonite with replaced peaty matter, covered by drift cemented by limonite into a breccia.

Another trench, 100 feet distant from the last one, shows an 8-foot face, with 5 feet of brown, compact, sandy-like, loose limonite, that appears to have stratification.

About 600 feet distant from this is an area of bog ore, partly covered with water, showing on the surface newly-formed gelatinous limonite. The bog is covered by grass, with hemlock, balsam, and cedar up to 4 feet in diameter. The depth of the bog is undetermined.

The following notes are taken from previous reports. A pit "started from the creek-bed and ran up the gently sloping bank, showing in nearly horizontal layers, first, 4 feet of bog iron ore; next, one foot of gravel with a layer of fine . . . . clay on top; next, 9 inches of iron ore, then 2 feet of ochre and clay, above which was the black surface mould. A similar showing was seen in another cut about 150 feet farther up the creek, and these may be taken as typical of the more successful strippings made. . . . Samples from the lower 4-foot deposit . . . . gave 48·12-48·31 per cent and 50·19 per cent of iron, with much organic matter. The ochre and clay stratum assayed 36·6 per cent of iron" (29, page 149).

"On the hill-sides where the accumulation of the limonite has gone on without intervening disturbances, the ore is generally clean and free from other admixtures. In the dry season the limonite becomes hard, forming a solid crust, which, during the succeeding wet season, will be buried under more ore solution. The thickness of the ore thus accumulated varies considerably, depending on the supply of ore solution and the topography of the ground. If in a depression in the ground the ore may be quite thick, while, on the other hand, with a little elevation of the ground only a few feet from the latter place, none, or only a few inches of ore may exist. Thicknesses from a few inches to 6 feet were noted, but it was reported that in one place a thickness of 18 feet had been obtained by drilling. The greatest depth has been found in the vicinity of two creeks on the Eagle and Sunrise claims, and although the ore in many places is clean, some of the outcrops show a serious mixture of fractions of the country rocks embedded in it. These have been transported here during the wet season by the high waters from the hills above. The limonite has then been precipitated between them, and the whole now forms a kind of ore breccia. In the swamps, on the other hand, the ore is associated with peat, in layers of varying sizes.

"Two average samples taken from two different open-cuts, where the ore was clean, gave the following analysis:

—	I	II
	Per cent	Per cent
Insoluble matter	2·32	1·40
Iron	54·46	56·97
Sulphur	0·15	0·447
Phosphorus	0·038	0·038

ORIGIN OF THE DEPOSIT

The iron hydrate seems to have originated with the oxidation of the pyrite of the country rock and the partial removal in solution and suspension of the products of this decomposition, by small streams and subsoil drainage. Drift and peaty material lying on the side hills through which these waters percolated were cemented and partly replaced; while the remaining parts of these products were carried down to the flatter areas and deposited with clayey sediment as bog iron ore.

ECONOMIC CONSIDERATIONS

With the small extent of the present development, and on account of the overburden of vegetation, it is impossible to make any estimate as to the amount of limonite available in this deposit. The claims cover an area of a little over one square mile, but there is no reason to suppose from present indications that the limonite deposits are co-extensive with that area. The depths of the deposits vary from zero at the margins to a reported figure of 14 feet in one pit. There is no means of arriving at an average figure for this vertical dimension. However, a calculation based on an area of one square mile with a depth of 5 feet would, no doubt, result in a very liberal estimate of quantity. The tonnage of undried material represented by such a volume would be in the neighbourhood of 5,000,000. After ignition, this tonnage would be reduced 60 or 70 per cent, giving as the weight of dry limonite less than 2,000,000 tons. This figure would comprise a great deal of sandy, clayey, and rocky matter that would reduce to a low figure the percentage of iron contained. In addition, it must be remembered that such a calculation does not take into account barren areas within the confines of the one square mile. This figure of 2,000,000 tons (which is in no sense an estimate) will give some idea of the maximum size of the deposit, but it is to be expected that the tonnage of commercial grade would only amount to a small percentage of such a figure.

It is hardly possible that the value of the material in such a deposit could stand the expense of stripping, drying, cleaning, and transportation necessary to bring it within the sphere of operations of a blast furnace.

Bibliography

See page 158 for further details

6. Carmichael, H., p. 206.
16. Lindeman, E., pp. 17-18.
20. Lindeman, E., and Bolton, L. L., pp. 13-14.
21. Brewer, W. M., pp. 29-30.
22. Whittier, W. H.
29. Ann. Repts., 1903, pp. 202-203, p. 195; 1905, pp. 212-213; 1906, p. 183; 1907, p. 149.

OTHER MAGNETITE OCCURRENCES NEAR THE WEST COAST

Many other occurrences of magnetite are known in the country tributary to the west coast, and a few of these were visited. They are not of interest primarily as sources of iron ore, consequently they are only given brief mention in this report. Such occurrences are the following:

(a) Of prime importance as probable and possible copper producers (magnetite is an important gangue mineral)

Old Sport Mine, Coast Copper Company, at Elk Lake, near Quatsino Sound

(References: Ann. Rept., Minister of Mines, B.C., 1916, pp. 340-341; Dolmage, V., Geol. Surv., Canada, Sum. Rept. 1918, pt. B, pp. 33-35.)

Merry Widow Deposit, Adjoining the Old Sport

(References: Ann. Rept., Minister of Mines, B.C., 1916, p. 341; Dolmage, V., Geol. Surv., Canada, Sum. Rept. 1918, pt. B, p. 35.)

Tidewater Mine of Sydney Inlet Mining Company, Sydney Inlet

(References: Ann. Rept., Minister of Mines, B.C., 1917, pp. 248-254; Dolmage, V., Geol. Surv., Canada, Sum. Rept. 1920, pt. A, p. 20.)

Waterloo Deposit, Kokshittle Arm, Kyuquot Sound

(References: Dolmage, V., Geol. Surv., Canada, Sum. Rept. 1920, pt. A, p. 21.)

(b) Black Sand Deposits (auriferous)

Wreck Bay Placers

(References: Ann. Rept., Minister of Mines, B.C., 1902, p. 233; Dolmage, V., Geol. Surv., Canada, Sum. Rept. 1919, pt. B, p. 16.)

Additional to the above is an occurrence on an island in the Walker group near the north end of Vancouver island as mentioned by Dawson.[1]

[1] Geol. Surv., Canada, 1889, "Mineral Wealth of British Columbia," p. 151.

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